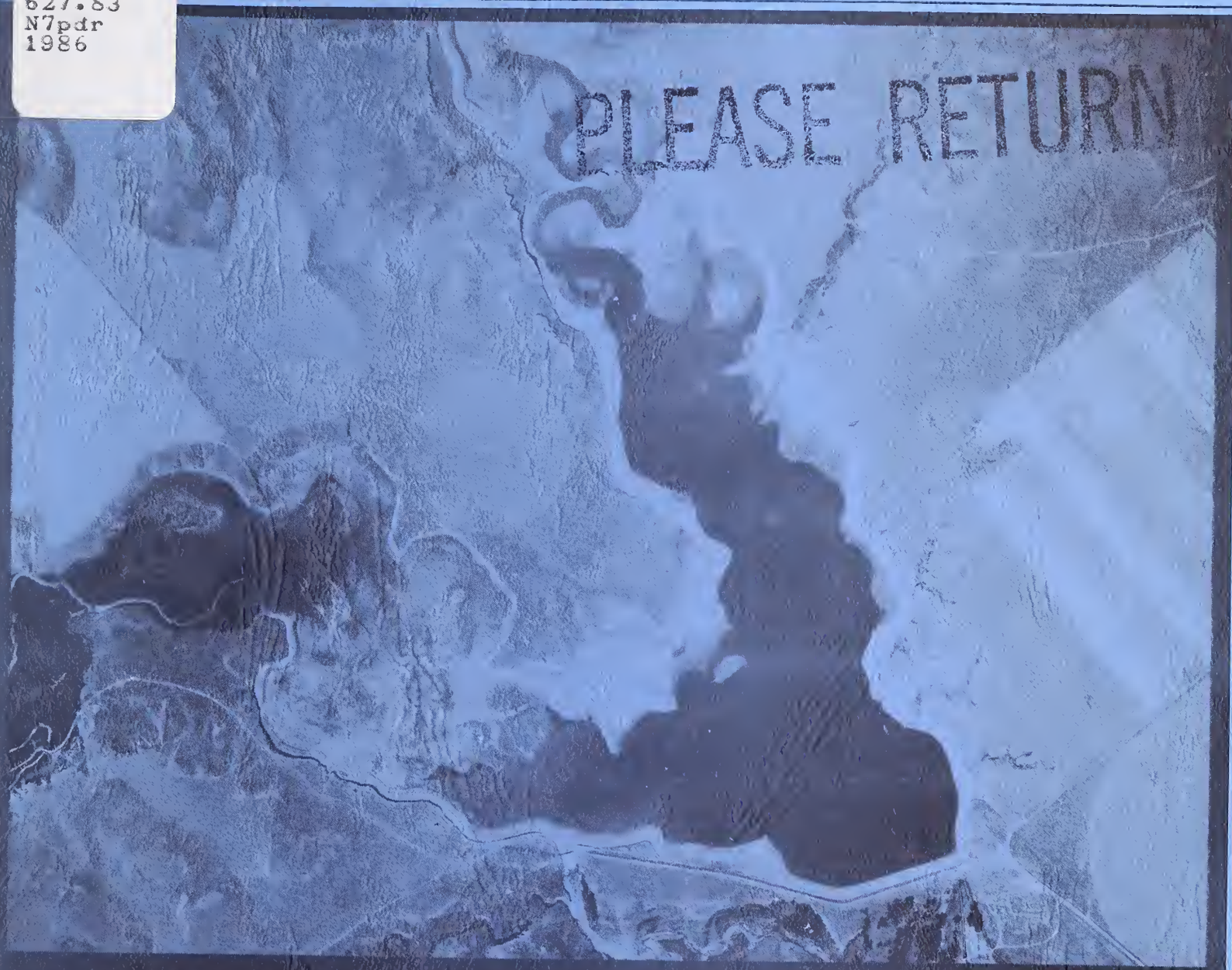
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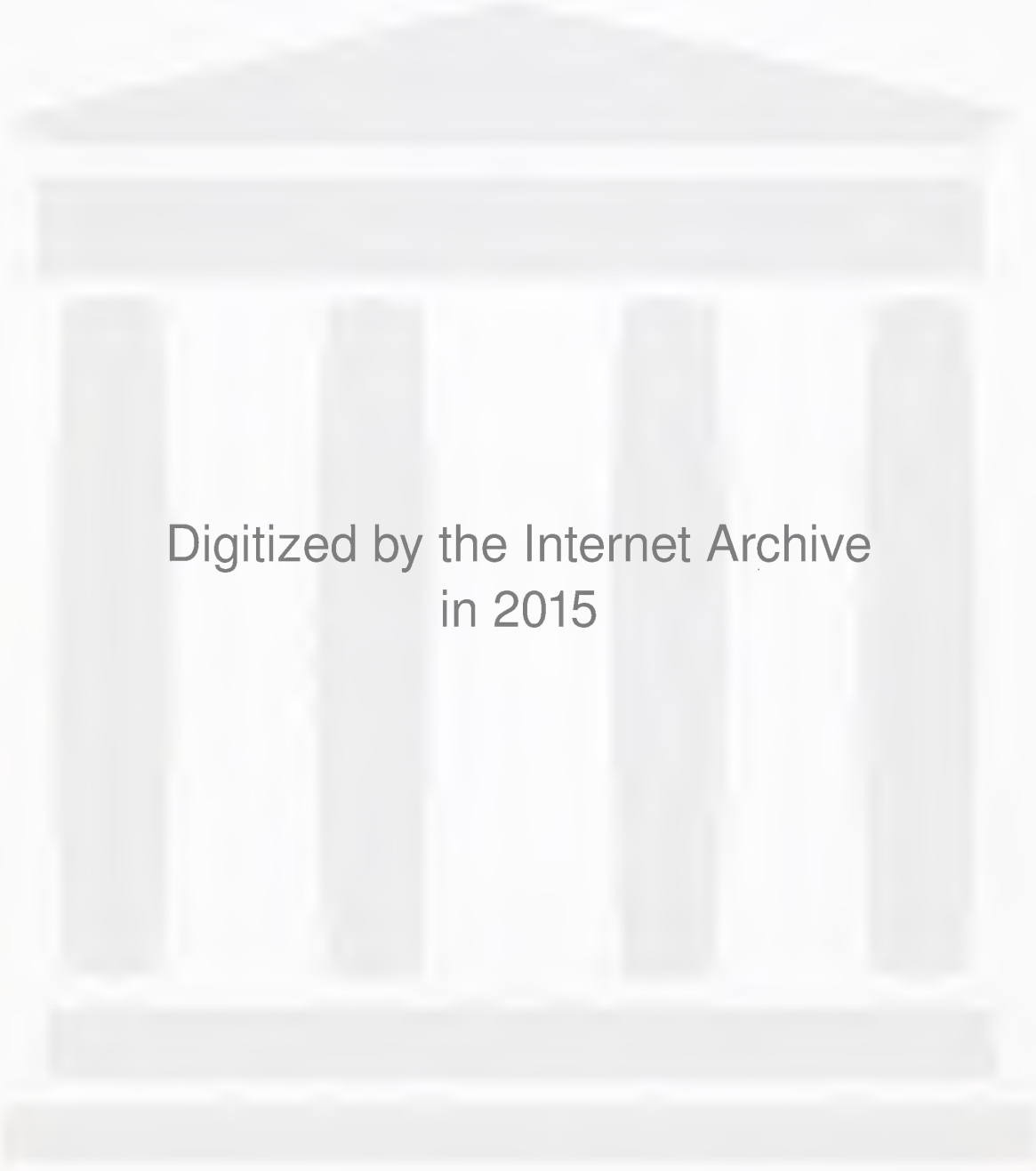
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LIST OF ABBREVIATIONS

Ac - Acre
AF - Acre-feet
AMEC- Agricultutal Management and Economic Consulting, Inc. (economic subcontractor)
cfs - Cubic feet per second
cm - Centimeter
COE - U.S. Army Corps of Engineers
CSED- Committee on the Safety of Existing Dams
DNRC- Department of Natural Resources and Conservation
EC - Electrical Conductivity
FmHA- Farm Home Administration
fps - Feet per second
ft - Feet
HEC - Hydrologic Engineering Center
hr - Hour
ie - In example
in - Inches
JTU - Jackson Candle Turbidity Units
LDC - Lotus Development Corporation
' - Feet
" - Inches
MDFWP- Montana Department of Fish, Wildlife and Parks
mmhos- Unit of electrical conductivity
mph - Miles Per Hour
MWRB- Montana Water Resources Board (now DNRC)
NGVD- National Geodetic Vertical Datum
NE1/4 SE1/4 Sec. 27, T.14N. R.28E. - Location description. This example indicates the northeast quarter of the southeast quarter of Section 27 in Township 14 north, Range 28 east.
O&M - Operation and Maintenance
OM&R- Operation, Maintenance, and Replacement
OMR&P- Operation, Maintenance, Replacement and Power

LIST OF ABBREVIATIONS (Cont.)

PL	-	Public Law
PMF	-	Probable Maximum Flood
PMP	-	Probable Maximum Precipitation
PWUA	-	Petrolia Water Users Association
RBG	-	Rollins, Brown & Gunnell (drilling subcontractor)
Right, Left	-	Refers to looking downstream
SAR	-	Sodium Adsorption Ratio
SCS	-	Soil Conservation Service
SHPO	-	State Historical Preservation Office
sq. mi.	-	Square Miles
SWCB	-	State Water Conservation Board (later MWRB, now DNRC)
USDI	-	U.S. Department of the Interior
USGS	-	U.S. Geological Survey
USBR	-	U.S. Bureau of Reclamation
USDA	-	U.S. Department of Agriculture

PROJECT SUMMARY

PETROLIA DAM

REHABILITATION FEASIBILITY STUDY

LOCATION

The Petrolia Dam and Reservoir are located in Petroleum County, Montana in Township 14N Range 27E. The dam is approximately 6 miles east and 5 miles south of the County Seat of Winnett, Montana. The dam impounds water from Flatwillow and Yellow Water Creeks, which are tributaries of the Musselshell River.

ORGANIZATION

The Petrolia storage project is owned by the State of Montana and administered by the Engineering Bureau of the Department of Natural Resources and Conservation (DNRC). The project is operated and maintained by the Petrolia Water Users Association (PWUA).

PLAN

PURPOSE

Dam safety investigations have indicated that deficiencies exist in the dam structure, outlet works, abutments, and spillway capacity. This feasibility study was conducted for the State by HKM Associates to determine the feasibility of rehabilitation and enlargement of the facility.

This rehabilitation plan proposes measures that would provide adequate spillway capacity to pass the probable maximum flood (PMF), control seepage in the abutments, rehabilitate the outlet works, and rehabilitate or replace the principal spillway system. These measures would upgrade the dam to present dam safety standards.

PROPOSED PHYSICAL WORKS

The principal project features are:

1. Construction of an auxiliary spillway.
2. Partial reconstruction of a principal spillway.
3. Construction of a fuse plug spillway.
4. Enlargement of the dam embankment.
5. Drainage control system on both abutments.
6. Protection of the embankment from large flood flows in Johnson Coulee.
7. Modification of the outlet works.

Project Costs

Principal Spillway	$ 547,707
Auxiliary Spillway	435,679
Fuse Plug Spillway	142,222
Dam Enlargement and Drainage	573,688
Canal Rehabilitation	19,302
Total Direct Cost	$1,718,598
Contingencies (20%)	$ 343,720
Project Cost Increase (10%)	$ 206,232
Engineering and Administration (14%)	$ 317,597
Rights-of-Way and Water Rights	$ 11,000
USBR Participation	$ 60,000
Archeology Costs	$ 50,000
Loan Application Report	$ 224,000
Total Project Cost	$2,931,146

Annual Costs*

P.L. 984 Loan Repayment	$ 42,600
Existing Debt Repayment	$ 13,682
O,M&R	$ 17,021
TOTAL ANNUAL COST	$ 73,303

* The annual cost distribution changes in the 27th-38th years when the existing DNRC and FmHA loans are paid off and the excess money from the state debt payment is added to the P.L. 984 payment. The total annual cost remains at 100% of payment capacity.

PROPOSAL

Total Project Cost	$2,931,146
PL 984 Loan	$1,765,146
Federal Grant	$ 150,000
State Contribution	$1,016,000

Acquisition of Right-of-Way	$ 6,000
Feasibility and Loan Application Report	$224,000
Filing Fee	$ 1,000
State Grant	$730,000
Archeology	$ 50,000
Water Rights	$ 5,000

LAND

LAND CLASSIFICATION

Presently, there are 5173 acres irrigated downstream of Petrolia Reservoir on Flatwillow and Box Elder creeks, of which 4890 acres are project lands. An additional 6740 acres are irrigable lands in this area.

LAND USE

The irrigated lands served by Petrolia produce a crop mix of 46% alfalfa, 42% grass, and 12% small grains historically.

LAND OWNERSHIP

Current contracts for project water number 18 for a total of 4863 acres. Petrolia Reservoir lies on 578.37 acres of state-owned land and 163.54 acres of easement.

Within the project, there are no acres of irrigated land held in excess of the 960 acres per owner limitation established by the USBR for interest-free loans under the PL 984 loan program.

WATER AVAILABILITY

WATER SUPPLY	Total (acre-feet)
Firm Yield	10,810
80% Chance Reservoir Yield	12,129

WATER USE

Crop	Irrigated Acres	Net Irrigation (in)	Requirement (AF)
Irrigated Grass Hay	2,054	13.95	7,362
Alfalfa	2,249	17.19	9,989
Small Grain	587	11.67	1,986
TOTALS	4,890 Ac		19,337 AF

WATER RIGHTS

Water rights for the reservoir and the existing project lands belong to the state. Private senior water rights downstream of the reservoir are supplied by the direct flows when needed. Application for new storage will not be required. The problem of junior appropriators using water which can be stored in the reservoir will be investigated due to complaints by the PWUA. A $5,000 allowance is provided for this purpose.

PAYMENT RESOURCES

The agricultural payment capacity is estimated to be $15.07 per acre. With contracts of 4,863 acres, the annual payment capacity of the project will be $73,303.

FINANCIAL PROGRAM

Period of Repayment	38 Years
Interest Rate	-0- %

Annual Assessment*

P.L. 984 Loan Repayment	$42,600
Existing State Debt Repayment	$13,682
O,M&R	$17,021
Total Annual Cost	$73,303

* The annual cost distribution changes in the 27th-38th years when the existing state debt is paid off and the excess money from the state debt payment is added to the P.L. 984 payment. The total annual cost remains the same.

ENVIRONMENTAL ASSESSMENT

Environmental impacts associated with this rehabilitation would be minor. The only significant environmental aspect of this project concerns possible impacts to the cultural resource sites surrounding Petrolia Reservoir during flood events greater than the 100-year flood. The operating pool would remain the same after rehabilitation, so increased impacts over the present situation would be felt only during rare floods. Short duration increases of water levels could result in minor damage to these sites due to wave action. It is recommended that a "Finding Of No Significant Impact" (FONSI) be prepared in compliance with the National Environmental Policy Act.

Additional investigation of the affected sites would be required in order to properly evaluate National Register significance and develop an appropriate mitigation plan.

CHAPTER 1

GENERAL INFORMATION

PROJECT LOCATION

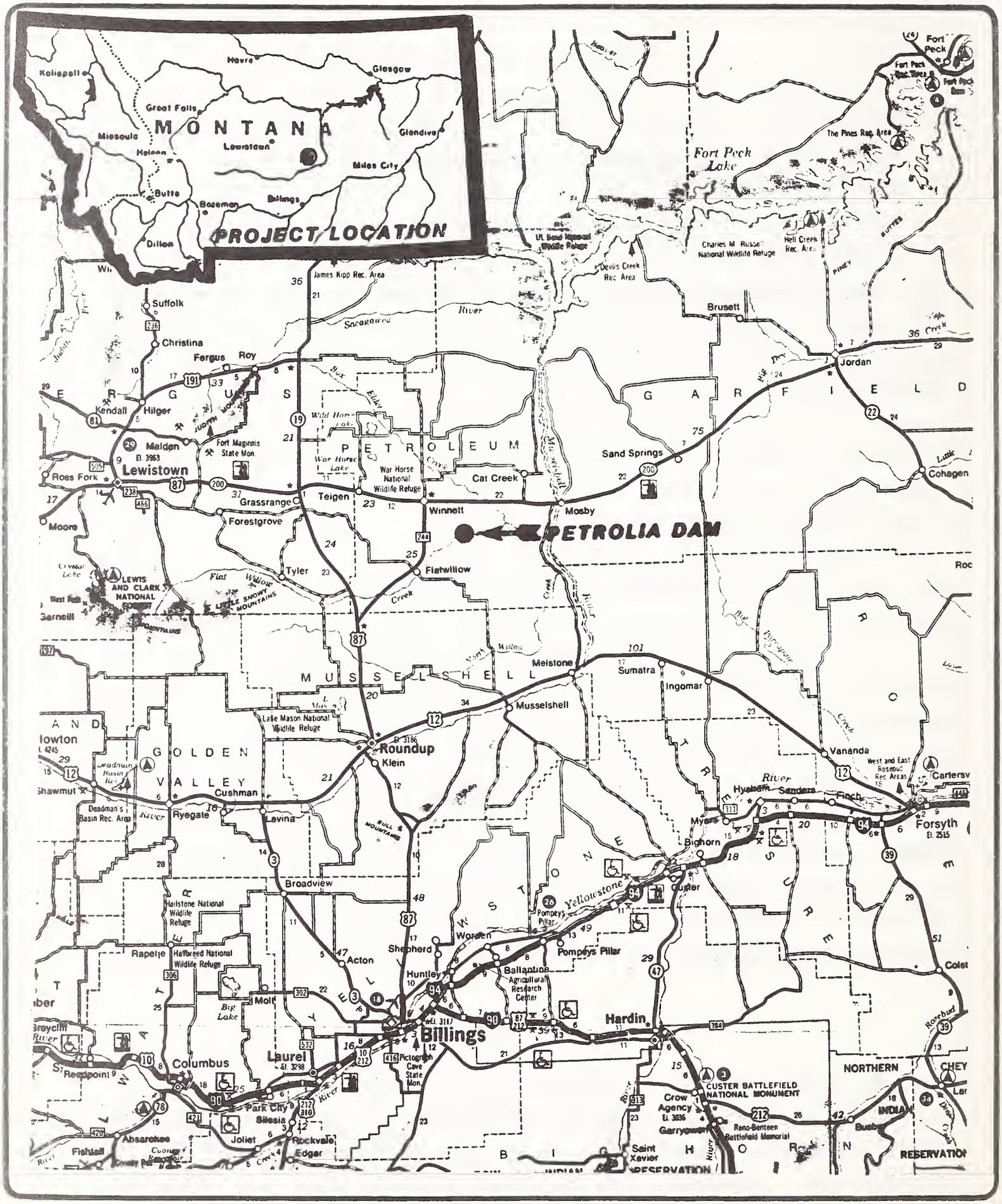
The Petrolia Dam and Reservoir are located in Petroleum County Montana in Township 14N Range 27E. The dam is approximately 6 miles east and 5 miles south of the County Seat of Winnett, Montana (see Figure 1.1).

Irrigated lands served by the project lie on benchlands along Flatwillow and Box Elder creeks within an area 7 miles east and 5 miles north of the reservoir.

The dam was constructed to form a reservoir storing 9,192 acre-feet (AF). Project facilities also include a pump (used to lift water at low reservoir levels) and a series of distribution canals. The total amount of acreage originally intended to be served by the project was 5,300 acres (Ac). The State Water Conservation Board (SWCB) authorized construction of the project on May 2, 1950 and acquired a water right on Flatwillow Creek to supply the water needed for the project (DNRC, March 1977). A 1984 survey by Associated Surveys Inc., of Billings, Montana was used to compute the present capacity of Petrolia Reservoir at 8,380 AF (Streamworks, 1985). The project currently serves 4,890 Ac of irrigated land.

CLIMATE

The regional climate is classified as distinctly continental, and characterized by abundant sunshine, low relative humidity, light rainfall, and wide daily and seasonal variations in temperature. However, the regional climate does not have the extreme variable pattern common to the more mountainous western



GENERAL LOCATION MAP

FIGURE 1.1

HKM ASSOCIATES
ENGINEERS-PLANNERS

sections of Montana. In general, the valleys are relatively dry during the colder months (October-March) and wet during the late spring and summer (April-September). The wettest part of the year in the mountains is generally from midwinter to early spring. Snowfall in the prairie sections of the Petrolia watershed is generally light and does not tend to remain on the ground for long periods of time. It is not uncommon for the region to experience winter warming spells with associated thawing temperatures. Precipitation in the Petrolia watershed ranges from about 13.5 inches at Flatwillow (10 miles southwest of the dam) to amounts in excess of 50 inches in the Big Snowy Mountains. The average annual temperature at Flatwillow is approximately 45°F. Winters are typically cold, with January being the coldest month. The monthly average temperature for January at Flatwillow is about 20°F. During the summer, July is typically the warmest month with an average temperature of about 70°F (COE, December 1980 and NOAA, N.D.).

Further information on climate can be found in the hydrology report (HKM, June 1985).

PREVIOUS INVESTIGATIONS

Numerous investigations have been completed for Petrolia Dam. This plan addresses those problems identified previously.

The DNRC has completed annual inspections at Petrolia Dam since the early 1970's. Several Operation and Maintenance (O&M) problems were identified through this process and some emergency repairs have been made.

Seepage in Johnson Coulee was investigated by the SCS. Substantial seepage was observed high on the vertical banks above Johnson Coulee. These seepage areas exist between the right abutment of the main dam and the principal spillway. Observation wells were installed to monitor the ground water table between the reservoir and Johnson Coulee. Although storage water was being lost, it was determined that safety of the structure was not immediately threatened.

As part of the National Dam Safety program (P.L. 92-367), Petrolia Dam was evaluated for hydraulic, structural, and operational adequacy. The Corps of Engineers Phase 1 report (COE, December 1980) described the dam's condition and provided several recommendations for project improvement. The dam was found to be unsafe, mainly due to lack of spillway capacity. The key recommendations (COE, Dec. 1980) are summarized as follows:

1. Immediately develop, implement, and periodically test an emergency warning plan for use in the event of dam distress.

2. Perform studies to determine the reasons for the spillway subgrade deterioration. Modify the spillway area as studies indicate to prevent future deterioration. Perform the following repairs on the spillway: replace and regrade the gravel and cobble material where necessary in the approach channel; fill the scour hole immediately upstream of the ogee crest; repair concrete along the floor and walls, and at the flip bucket; repair the concrete on the spillway walls near the anchor bolts for the footbridge; provide relief for the standing water in the flip bucket; and repair the stilling basin. Stilling basin repairs are detailed in Recommendation #4.

3. Perform the following repairs on the outlet works facility: apply corrosion-resistant protective coatings to all gates; repair the gate seat on the emergency slide gate; repair cavitation/erosion areas on the metal seat rings for the emergency and operating gates in control tower; repair the small leaks and erosion points in the concrete conduit; repair the concrete deterioration in the second wet-well chamber (chamber housing the vertical turbine pump); and repair the stilling basin. Stilling basin repairs are detailed in Recommendation #4.

4. Repair and replace riprap in the following areas: along the upstream face where the embankment has been eroded and the rock has moved downslope; in the outlet works stilling basin where severe undercutting and erosion have occurred in the basin and where the rock sidewalls have subsided; and in the spillway stilling basin where channel degradation and localized bank erosion have occurred.

5. Using suitable material, fill and properly compact all depressions along the dam crest.

6. Install additional piezometers in the embankment, abutments, and foundation to evaluate the seepage conditions. Establish a regular monitoring program for the underseepage and abutment seepage. Particular attention should be given to periods when the reservoir pool is relatively high. The results of the monitoring program will be used in Recommendation #9.

7. Repair all erosion gullies on the downstream embankment face, particularly the major gully along the downstream side of the left abutment contact.

8. Conduct more detailed hydrologic and hydraulic routing studies to better determine the downstream hazard and required spillway capacity. Include input from the upstream Yellow Water Reservoir in these studies and modify the project as studies indicate.

9. Conduct and place on file, stability and seepage analyses of the embankment. It is recommended that these analyses be performed by a qualified geotechnical engineer and be based on: static loading conditions, in situ strength properties of the embankment, foundation, and abutment materials; and phreatic surface conditions. Establish the material strength properties by drillings and sampling with laboratory testing as appropriate; and obtain the phreatic surface by evaluating the results of the piezometer monitoring program. Modify the project as studies indicate.

10. Monitor the bank erosion and sloughing on the left stilling basin wall of the spillway and perform the necessary rehabilitation.

11. Determine whether the cutoff wall on the spillway crest contacts bedrock, and assess the possibility of flow passing under the cutoff.

12. Conduct periodic inspections by qualified engineers at least once every five years to determine whether there are any deficiencies in the condition of the project, to assess the adequacy and quality of maintenance, and to evaluate methods of operation. Include an inspection of all conduits through the embankment.

13. Develop and implement a periodic maintenance plan for the dam and appurtenant structures.

In October 1982, the DNRC contracted with Morrison-Maierle, Inc. to do a seepage analysis and preliminary stability analysis at the dam. Their report stated that the dam was unstable and that the sandstone bedrock was allowing seepage to exit around the left abutment. They recommended a detailed stability analysis and further geotechnical studies at the dam (DNRC, 1985). HKM Associates was retained to perform a complete rehabilitation feasibility study.

CHAPTER 2

ORGANIZATION

HISTORY

The Petrolia Water Users' Association (PWUA) was incorporated on April 21, 1950. It has authority to issue 10,000 shares of stock at $1.00 per share and is governed by a board of three directors (DNRC, 1985).

CONSTRUCTION CONTRACTS

Contract for construction of the project was awarded to Haggerty and Messmer on their bid of $252,695.00 on June 1, 1950. This contract was completed on August 2, 1951. Since completion of the original construction work the DNRC has constructed a new cut-off trench to minimize leakage through dike section of the dam and has done considerable work on the canals. Repairs have been made to the spillway, including replacement of portions of the slab and foundation gravel (DNRC, 1985).

WATER PURCHASE CONTRACTS

At the time the State Water Conservation Board (SWCB) proceeded with the construction of the project there were 4,896 acres of land signed up under contracts to pay $2.00 per acre for a term of fifty years. On December 5, 1955, after a survey of the lands actually being irrigated, it was necessary to reduce these contracts so there were outstanding contracts for 2,240 acres. Because of the failure to get a water supply in storage in 1958 the payment for that year was deferred.

The remaining balance of the outstanding debt is $333,792.00, as of April 1985, to be repaid by eighteen outstanding water purchase contracts totalling 4,863 acres (DNRC, 1985).

POWER AND AUTHORITY OF DNRC

During its 33-year existence, the SWCB had the responsibility to construct, operate, and maintain water conservation projects. In 1967, the SWCB was replaced by the Montana Water Resources Board (MWRB) and the new agency took on several new water resource-related activities in addition to those of the SWCB. Emphasis was shifted from construction of water conservation projects to maintaining and rehabilitating existing projects as well as providing engineering services for local groups and water users associations, and conducting annual maintenance inspections. Responsibility for operation and maintenance of the projects was gradually shifted from the SWCB and the MWRB to the local water users associations over a period of several years until finally the state agency serves mainly in a supervisory capacity.

Upon reorganization of state government in 1971, the MWRB was replaced by The Department of Natural Resources and Conservation (DNRC). The Engineering Bureau of the Department's Water Resources Division was delegated the responsibility for the projects.

FINANCIAL STATUS OF PWUA

Present assessments are $3.00/AF or $6.00 per acre assuming 2 AF of storage allocated per acre of irrigated land. Of the $6.00/Ac assessment approximately $2.80/Ac goes toward repayment of debt to DNRC and Farm Home Administration (FmHA). The balance, or $3.20/Ac, is used for operation, maintenance,

replacement, and power (OMR&P) expenditures. The PWUA does not own major maintenance or office equipment, so no equipment reserve fund or equipment maintenance expenditures are required. In 1984 and 1985, OMR&P expenditures were $4.30/Ac and $3.54/Ac respectively. The expenditure was unusually high in 1984 due to a major overhaul of the pump. The expenditure was also high in 1985 due to high energy costs resulting from a drought year. OMR&P expenditures were projected at $3.50/Ac for the purposes of the application based on a normal year and discussions with the water users. A Statement of Income and Expenditures for 1984 and 1985 can be found in Table 7.4.

CHAPTER 3

LANDS

LAND OWNERSHIP

Surface ownership plats were obtained from the Petroleum County Assessor's office. Ownership boundaries were projected onto a base map showing Petrolia Reservoir and areas east along McDonald, Box Elder, and Flatwillow creeks (Figure 3.1). Ownership and easement boundaries for the dam and reservoir are shown in Figure 3.2. Lands for T.14N. R.28E., E1/2 T.14N. R.27E., West 1/2 T.14N. R.29E., shown on Figure 3.3, include all the areas presently being served from Petrolia Reservoir and those areas which would have potential for future irrigation development if water was available.

The Department of Natural Resources and Conservation accounting system shows eighteen current contract members in the Petrolia Water Users Association (see Table 3.1). According to DNRC figures, 4863 acres of irrigated land are currently being served with Petrolia Dam storage water. Because additional direct flow irrigation water is available to irrigators from Flatwillow Creek and Box Elder Creek, HKM studies show 5173 acres of irrigated lands in the areas currently receiving Petrolia Dam storage water.

The delineations of arable land, those areas having potential for future development using Petrolia water, show that three owners, Bohn Ranch, Petaja Ranch, and the State of Montana would account for greater than 50% of the total arable land base. The remaining operators would account for smaller tracts (40 to 400 acres) of arable land.

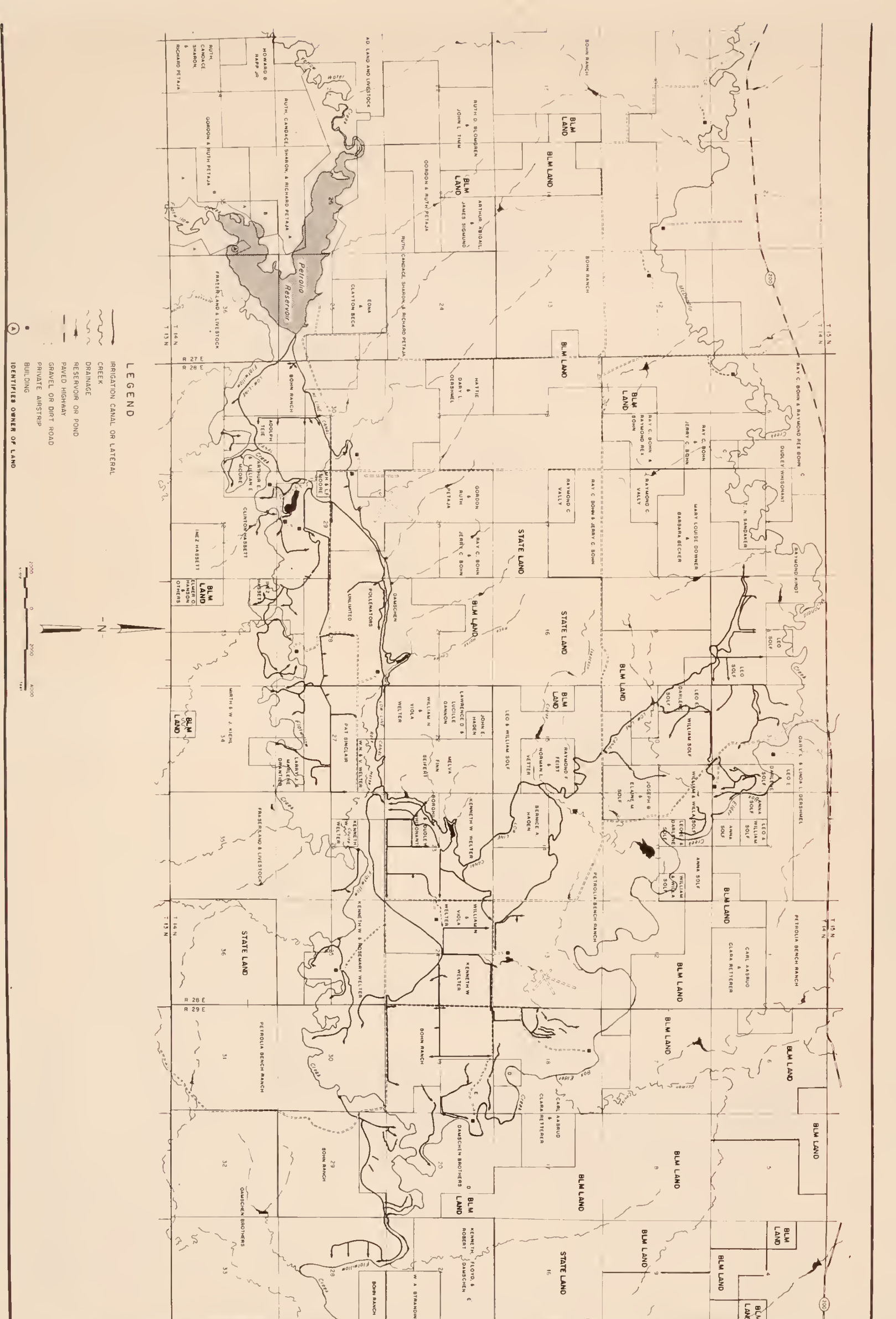


FIGURE 3.1

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Airport Industrial Park
P.O. Box 31318
Billings, Montana 59107

Branch Offices:
• Libby, Montana
• Sheridan, Wyoming

PETROLIA DAM
LAND OWNERSHIP MAP

PETROLIA DAM
PROJECT LAND DESCRIPTION

LEGEND

E E 163.54 ACRES FRASER EASEMENT

S S 578.37 ACRES STATE OF MONTANA

1,000 0 1,000 2,000
Scale Feet

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FIGURE
3.2

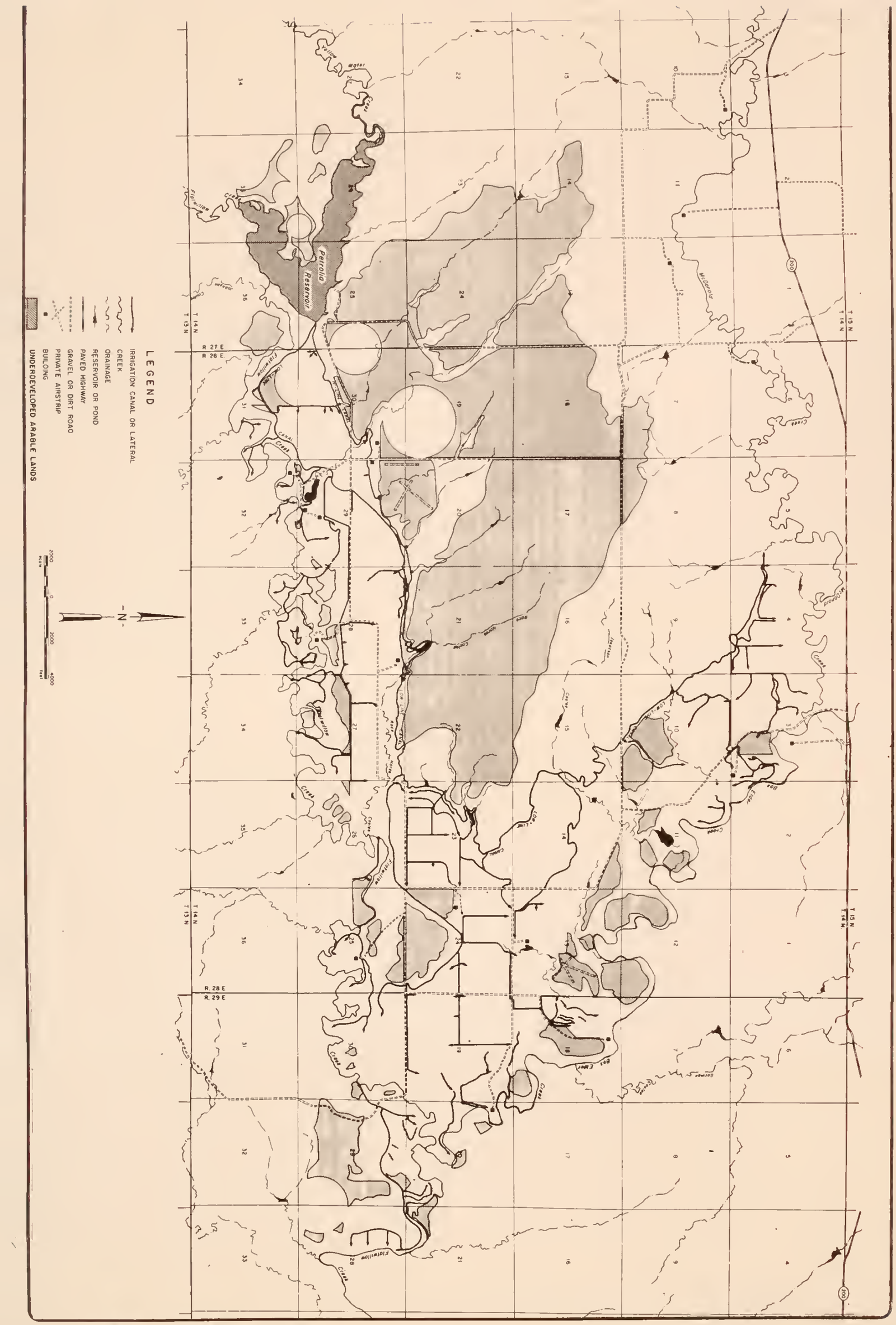


FIGURE 3.3

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PETROLIA DAM
UNDEVELOPED ARABLE LAND BASE MAP

TABLE 3.1

PETROLIA WATER USERS ASSOCIATION MEMBERS AND CONTRACTS

Name	Contract Units
Petaja, Gordon	411 AC
Sinclair, Pat	650 AC
Solf, Leo	220 AC
Solf, Bill	220 AC
Petrolia Bench Ranch	480 AC
Whisonant, Joe	60 AC
Welter, Kenneth	295 AC
William Welter & Sons	60 AC
Welter, Wm & Viola	345 AC
Solf, Joe	50 AC
Bohn, Rex & Jerry	800 AC
Grantier, Larry	27 AC
Damschen, Ken	205 AC
Eike, Larry & Joyce	210 AC
Gershmel, Larry	200 AC
Hassett, Clinton	355 AC
Kiehl, Jack	175 AC
Moore, Arthur	100 AC
	4,863 Units on 18 Contracts

Petrolia Reservoir comprises 741.91 acres, of which 578.37 are deeded to the State of Montana and 163.54 acres are of easement (see Figure 3.2).

LAND CLASSIFICATION

A reconnaissance irrigation land classification was performed on approximately 8,000 non-irrigated acres in the vicinity of Petrolia Reservoir. Included were lands adjacent to the reservoir, non-water rights lands along Box Elder and Flatwillow creeks, and terrace lands that lie between the two streams (see Figure 3.3). This study did not assign economic classes to the lands, but rather screened out those lands that do not meet the basic physical criteria commonly required for arability (see Table 3.2).

TABLE 3.2
RECONNAISSANCE MINIMUM LAND CLASSIFICATION
CRITERIA FOR ARABILITY
PETROLIA RESERVOIR

Soils	
Texture	Loamy sand to friable clay
Salinity (E.C.)	16 mmhos/cm. maximum
Sodicity (SAR)	16 SAR
Topography	
Slope	15% maximum (sprinkler)
Drainage	
Depth to Barrier	5 feet

PROCEDURE

Mapping was performed in the field on 1980 1:12000 scale aerial photographs. The land within the designated study area was visually inspected, and a total of 12 holes were augered to a maximum depth of 72 inches. Gravels and/or cobbles limited to less than 3 feet the depth to which many of the soils could be augered. However, it is assumed that the gravelly/cobbly stratum will allow the lands to drain without artificial

drainage. A total of 6 soil samples were taken in areas that appeared to be affected by salinity or sodicity. Soils were analyzed for pH, electrical conductivity (E.C., extract test), and sodium adsorption ratio (SAR). Only one profile had levels of salinity or sodicity high enough to preclude irrigation (See Table 3.3). No drainage investigation was undertaken. Lands were eliminated that were clearly not drainable due to clay textures (restricted hydraulic conductivities) or shallow depths to sandstone or shale (restrictive drainage barrier).

TABLE 3.3

SOIL ANALYSIS OF SELECTED SAMPLES NEAR PETROLIA RESERVOIR

USDA Aerial Photo No.	Profile No.	Depth	pH	E.C.	SAR
178-311 (7/11/80)	1	0-12"	7.9	0.8	0.2
		12-24"	8.1	0.5	0.4
479-23 (7/21/80)	6	10-24"	8.1	1.5	1.4
378-27 (10/9/79)	1	0-10"	8.1	1.8	12.8
		10-20"	8.2	12.5	30.1
		20-36"	8.2	16.0	33.1

The mapping was performed utilizing sprinkler irrigation standards. Tracts that are too small or irregularly shaped for mechanical move irrigation systems can be irrigated either with hand move irrigation systems or by gravity systems.

Minor draws or other physical features that might affect system layouts were included due to the low intensity of the mapping.

In addition to the irrigable land mapping, those irrigated lands that have no water right (as per the water rights map provided by DNRC) were roughly delineated. Individual fields were outlined, and the acreages of the land actually receiving water quantified.

Three major land forms lie to the east of Petrolia Reservoir; the alluvial bottom lands, the high alluvial terraces, and the shale uplands. The majority of the irrigated acreage lies on the terraces, and smaller fields are found among the meanders of Flatwillow Creek (see Figure 3.4). Very little of the shale uplands are currently developed. There are two levels of terraces in this area, but the majority of the irrigation is on the lower deposit. Two center pivots are found on the higher terrace, and nearly all of the terrace lands within the irrigation project are presently irrigated. There are isolated non-water right tracts that are non-irrigable, and a minor acreage of water rights lands that are not irrigated and are non-irrigable. The notable example is NE 1/4 NE 1/4 Section 27 T.14N. R.28E.

The largest block of non-irrigated land irrigable by the project, (140 acres) lies in the south half of Sec. 24 T.14N. R.28E. The land is too high to serve with a gravity system, but could be served by pumping quite easily.

An additional 300 acres of non-water rights lands could possibly be served fairly easily by gravity methods or by pumping above canals.

The serpentine nature of Flatwillow Creek has resulted in the bottom lands being cut into a large number of small tracts. Most of these small fields are presently irrigated (see Figure 3.4). A number of parcels, usually less than 10 acres in size

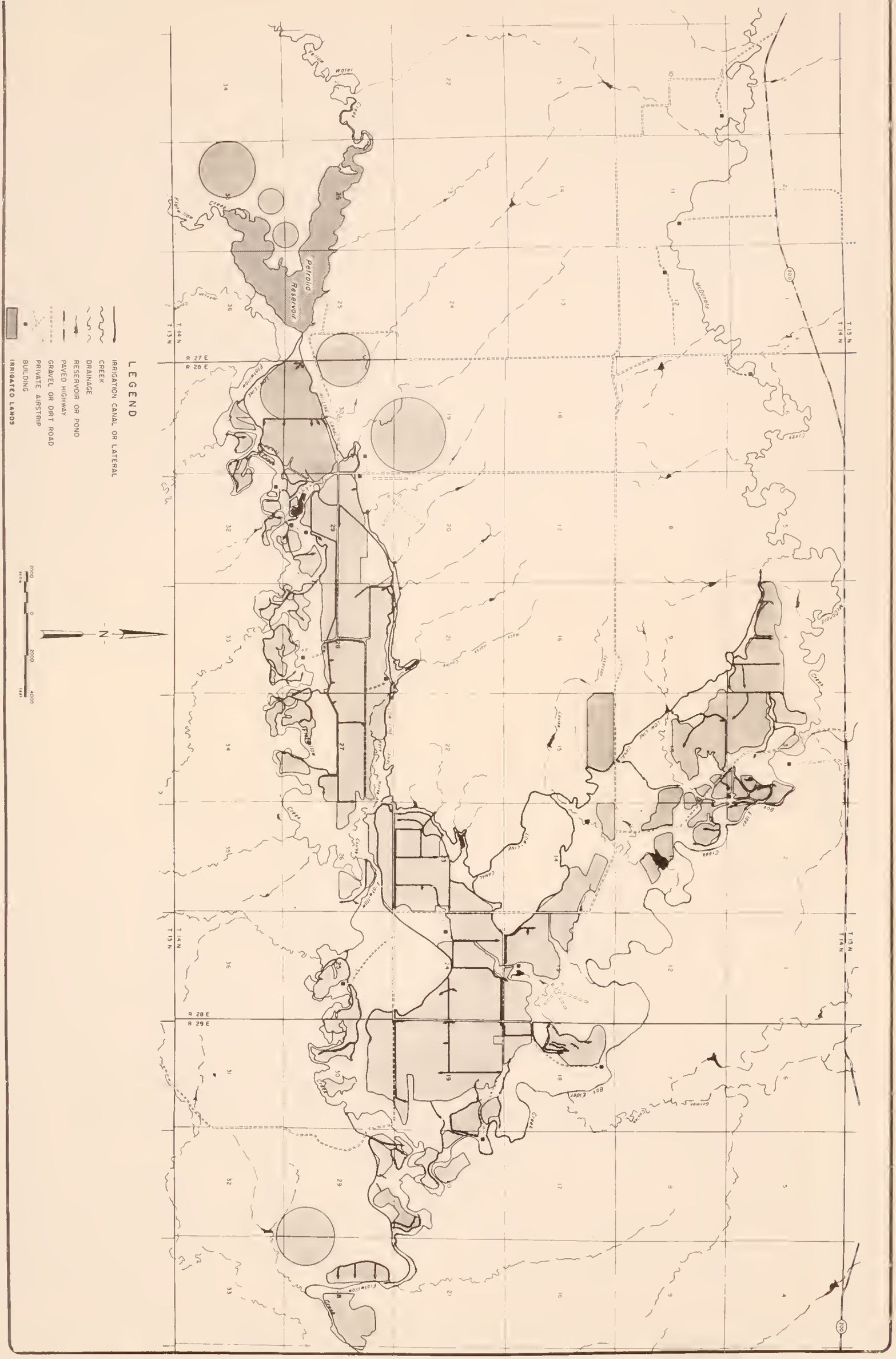


FIGURE 3.4

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PETROLIA DAM
IRRIGATED LAND MAP

and totaling approximately 230 acres, could possibly be irrigated. Size and field shape, high water table, and flooding are the major limitations that hinder development of these bottom lands.

Box Elder Creek is less meandering than Flatwillow Creek and thus the fields are relatively large. Although roughness is a factor on some parcels (i.e. SE 1/4 SE 1/4 Sec. 12 T.14N. R.28E.) many fields that are now being dry farmed or are in range could be placed under irrigation. Good irrigation management may be required to prevent these rather heavy soils from developing drainage problems. Approximately 600 acres are potentially irrigable along Box Elder Creek.

The large terraces that lie between the two streams comprise about 5200 acres of undeveloped lands. Other scattered parcels within or near the irrigation project account for nearly 750 acres. A total of 6742 potentially irrigable acres were mapped in this study. An acreage summary is presented in Table 3.4.

TABLE 3.4

POTENTIALLY IRRIGABLE LANDS BY AREA

Flatwillow Creek	369 acres
Box Elder Creek	636 acres
Terrace Lands and Other Scattered Tracts	5,737 acres
TOTAL	6,742 acres

Terrace soils range between loams and clay loams that are usually 24 to 36 inches deep over gravels. Although water holding capacity is often limited in soils this shallow, the

soil textures above the gravels are heavy enough to store adequate moisture for good crop yields.

A high non-irrigated terrace lies to the north and west of the irrigated lands primarily above the Low-Line Canal (Sec. 15-23, 29,30 T.14N. R.28E, and Sec. 13, 14, 23, 24, 25 T.14N. R27E). This terrace has similar soils to that of the irrigated lower terrace, with gravels appearing in the profile at about 24 inches. One sampled boring indicates that salinity and sodicity are not limiting for irrigated agriculture. This land is steeper than the lower terrace, and some areas are more suited to sprinkler irrigation due to the slope and deep draws. This terrace is suitable for sprinkler development due to the lack of roads or major topographic restraints. To the north of the terraces lie shallow residual soils derived from clay shales. The heavy textures, depth to shale (20 to 30 inches) and salinity/sodicity in the soil caused these soils to be mapped as non-arable. Those lands to the north of Sections 16, 17 and 18 T.14N. R.28E. have residual soils, and are non-arable lands.

Non-irrigated lands within the project that could be served with the present system are limited to about 150 acres. Several hundred additional acres could be served by pumping from the existing system or directly from the river.

In addition, a large block of suitable terrace lands lies above the Low-Line Canal. These lands are better suited in general to sprinkler rather than gravity irrigation.

The major limitations for irrigation are the steep slopes and limited water holding capacity of gravel soils.

LAND USE

Agricultural operations consist of: 1) irrigated alfalfa as a cash crop in seed production, 2) irrigated alfalfa to supplement winter feeding in operations where livestock is the primary enterprise, 3) irrigated small grains (wheat and barley) for both cash crop and livestock feed, and 4) livestock production.

Irrigated lands using Petrolia Reservoir water lie mainly north of Flatwillow Creek and southwest of Box Elder Creek and are served by two main delivery systems; the Hi-Line and Low-Line canals. The majority of the irrigated land is flood-irrigated with a few additional center pivots. The area northeast of Petrolia Reservoir includes the vast majority of lands suitable for future irrigation development.

The irrigated land study was initiated with the stereoscopic analysis of irrigated lands on 1"=1000' scale aerial photography. The irrigated land delineations were then field verified, transferred to the base, inked and screened, producing the irrigated lands map, Figure 3.4.

CHAPTER 4

WATER AVAILABILITY

NATURAL FLOWS

Natural inflows to Petrolia Reservoir have been given in a previous HKM Associates report titled Petrolia Dam Hydrology Report, June, 1985. The natural flows were needed to simulate the irrigation in the basin at the current level of development in order to determine if excess developable water exists for the project. The following discussion summarizes the results of the previous study.

The estimated average annual natural inflow to Petrolia Reservoir for the study period of 1922-1950 is 44,700 acre-feet (AF). The estimated average monthly inflow ranges from a low of 230 AF in October to a high of 14,300 AF in July. Natural flow estimates were developed at the gages Flatwillow Creek near Flatwillow and Flatwillow Creek near Winnett. Missing data at the Winnett gage was computed using regression equations developed between these two gages. Inflow to Petrolia Reservoir was determined to be 95% of streamflow at the gage near Winnett. The study period of 1922-1950 was selected based on a review of available streamflow records. This is a critical period in which the reservoir can be expected to go from full capacity, then be drawn down through an extended dry period and then be refilled again. Table 4.1 gives the natural flows into Petrolia Reservoir.

BASIN MODEL

Natural flows were adjusted to reflect present day irrigation (there are no municipal or industrial uses) by subtracting out depletions and accounting for storage in Petrolia and Yellow Water reservoirs.

TABLE 4.1
Petrolia Dam
Estimated Monthly Natural Inflow (AF)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Sum
1922	1140	791	8455	4760	11478	23223	11575	1717	0	0	856	1169	65165
1923	1330	950	1710	3002	7479	32913	39762	8972	3631	4118	3725	2945	110536
1924	2375	1900	3506	11495	16941	18758	14834	3272	737	441	1445	1748	77452
1925	1463	1710	4674	3325	6111	7776	10012	1610	0	0	645	751	38077
1926	467	422	467	627	4907	5743	10035	1610	0	831	0	409	25518
1927	285	257	4750	2052	31001	29303	14511	2721	1209	973	2072	1995	91128
1928	1710	1425	3040	3211	6975	5998	12791	1835	122	0	485	665	38258
1929	584	527	6650	2062	8486	10578	10459	1610	0	0	255	653	41866
1930	583	963	3211	3021	7321	6674	11776	1843	29	0	0	414	35836
1931	1074	1054	507	58	5582	6575	11370	1843	0	0	0	0	28065
1932	0	2	0	0	6998	21205	16842	2059	0	1	1	0	47110
1933	0	2	1	1	5868	6749	11602	1887	0	1	1	0	26113
1934	0	2	728	14	5832	6250	11148	1887	0	1	1	0	25863
1935	0	2	1	1	5868	6749	11602	1887	0	1	1	0	26113
1936	0	2	200	143	5896	6196	11148	1887	0	1	1	0	25474
1937	0	2	1	0	5830	6194	11148	1887	0	1	1	0	25065
1938	0	2	1	0	6060	8475	19304	2058	0	1	1	238	36141
1939	193	192	2218	605	7086	12175	14157	1896	0	1	1	127	38652
1940	103	268	1032	84	6060	6621	11148	1887	0	1	1	0	27295
1941	0	2	1	0	5840	7046	12772	3493	154	294	613	1417	31633
1942	1017	892	1834	5323	23636	33789	17683	4214	1083	6	31	753	90262
1943	780	2121	5442	1781	9139	34329	21588	3561	43	3	40	627	79453
1944	447	461	2148	525	6341	16095	19181	3394	3	1	7	508	49110
1945	420	283	1008	71	6147	11697	12638	1898	0	1	2	230	34396
1946	477	407	1097	100	6354	8720	11883	1887	0	1	2	305	31234
1947	236	355	4838	5408	7843	10938	12136	1927	1	1	5	246	43933
1948	345	307	1299	83	6698	14689	17400	2379	0	0	140	261	43602
1949	198	820	4798	545	6036	7002	11771	1913	0	0	0	0	33084
1950	0	32	1197	794	6011	7404	12308	1948	0	0	0	146	29841
Average	525	557	2235	1693	8477	13099	14296	2448	242	230	356	538	44696
Minimum	0	2	0	0	4907	5743	10012	1610	0	0	0	0	25065
Maximum	2375	2121	8455	11495	31001	34329	39762	8972	3631	4118	3725	2945	110536

PRIORITY DATES

Irrigation water was assumed to be used in order of priority date. Irrigated lands were grouped into categories tied to the priority dates of the two reservoirs; Yellow Water at 1935, and Petrolia at 1950.

POINT OF DIVERSION

Due to the cursory nature of this study, no attempt was made to separate land categories into individual ditches. Each land category was lumped into a single diversion. Figure 4.1 gives a schematic diagram of the Petrolia basin model.

MODEL INFLOWS

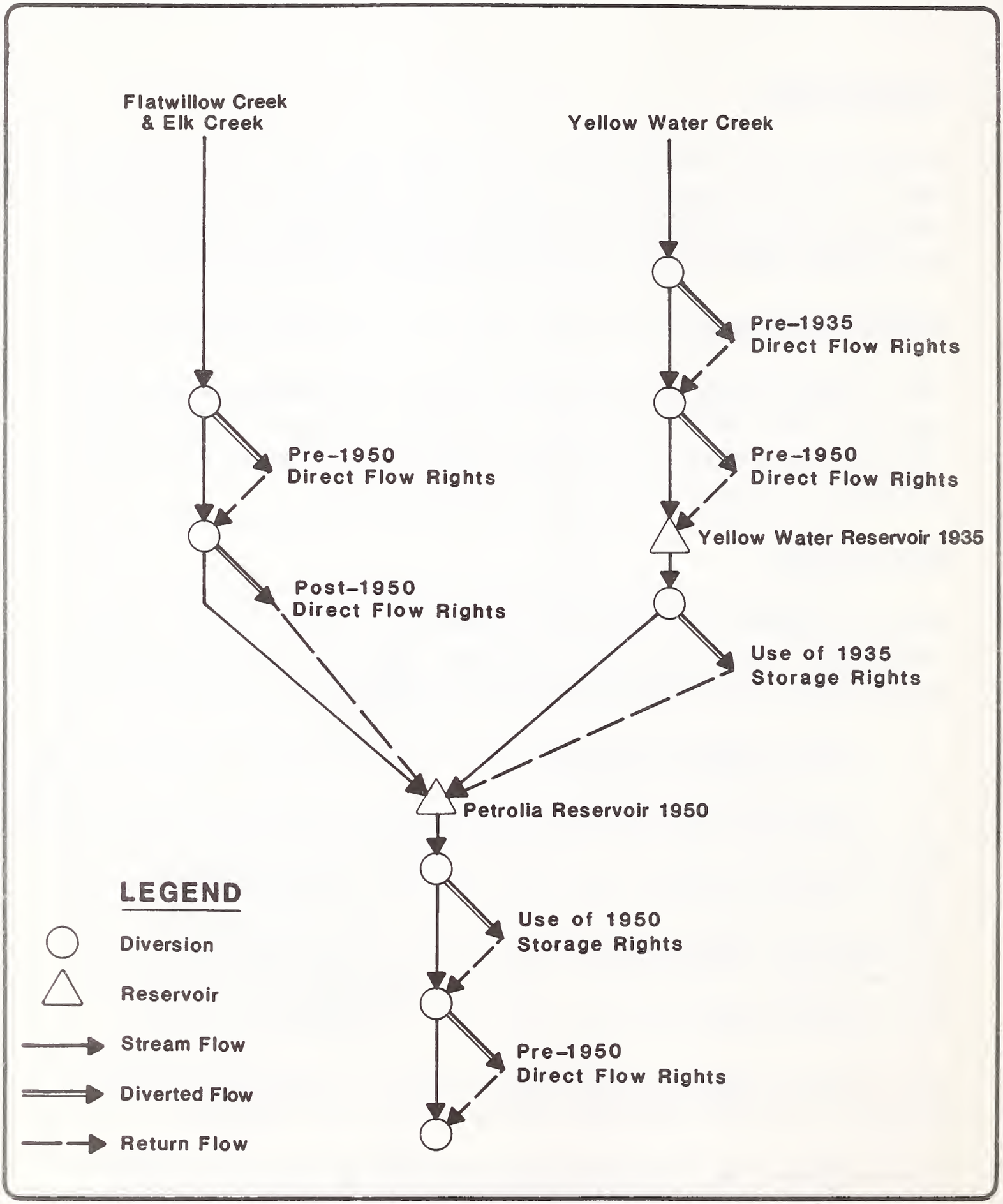
Natural inflows to Petrolia Reservoir (Table 4.1) were transferred upstream by drainage area to Yellow Water Reservoir. A flow transfer equation of the form:

$$\left(\frac{Q_1}{Q_2}\right) = \left(\frac{DA_1}{DA_2}\right)^N$$

where Q_1 and DA_1 are the flow and drainage area at one location and Q_2 and DA_2 are the flow and drainage area of another was used. The exponent in the equation was found for this basin by regression of the average annual flows and drainage areas of the two gages in the basin. By this method, the exponent N was found to be 0.51.

The natural flows at Yellow Water Dam were computed from the inflows to Petrolia Reservoir (Table 4.1) by the equation:

$$Q(\text{Yellow Water, AF}) = Q(\text{Petrolia, AF}) \times (55 \text{ sq mi}/612 \text{ sq mi})^{0.51}$$



PETROLIA DAM
FLATWILLOW CREEK BASIN
MODEL FLOW CHART

FIGURE 4.1

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The natural inflows to Petrolia from all other sources were computed to be the difference between the Petrolia inflows and the Yellow Water inflows.

ACREAGE

The irrigated acreages used in this study were taken from DNRC water resources survey of irrigated lands (DNRC, no date) and water rights claims under Montana Law 85-2-211. Unpublished DNRC water resources survey maps dated 1971 were used to identify acres developed prior to 1971. The water rights were then referenced to determine the approximate time that filings were made on the developed acres. The assumption was made that the development of each parcel took place in the same decade as the filing. Post 1973 development was assumed to follow the water rights claims exactly, due to the absence of current development maps.

Lands served by Yellow Water Reservoir were developed after 1948. Acreage information was compiled for this project by the DNRC in 1981. Even though project development did not begin until after 1948, it was assumed that all of the project lands had a 1935 priority. Some of the project lands had duplicate direct flow rights from Elk Creek. It was assumed that all of this land (285 Ac) was served by the Yellow Water Project.

Lands served by Petrolia Reservoir have a 1950 priority date. Many of the project lands have duplicate direct flow rights from Flatwillow Creek or tributaries, but conversations with the landowners indicate that the direct flow rights are essentially pooled with the project's stored water. Project acreage at the current level of development (August 1985) was established from records kept by the dam tender and ditch rider at 4890 acres. According to DNRC records, the total present project contracts equal 4863 Ac. Water rights claims for project lands total 5930 Ac and are shown on Figure 4.2. For modeling purposes, the current level of development used was 4890 Ac.

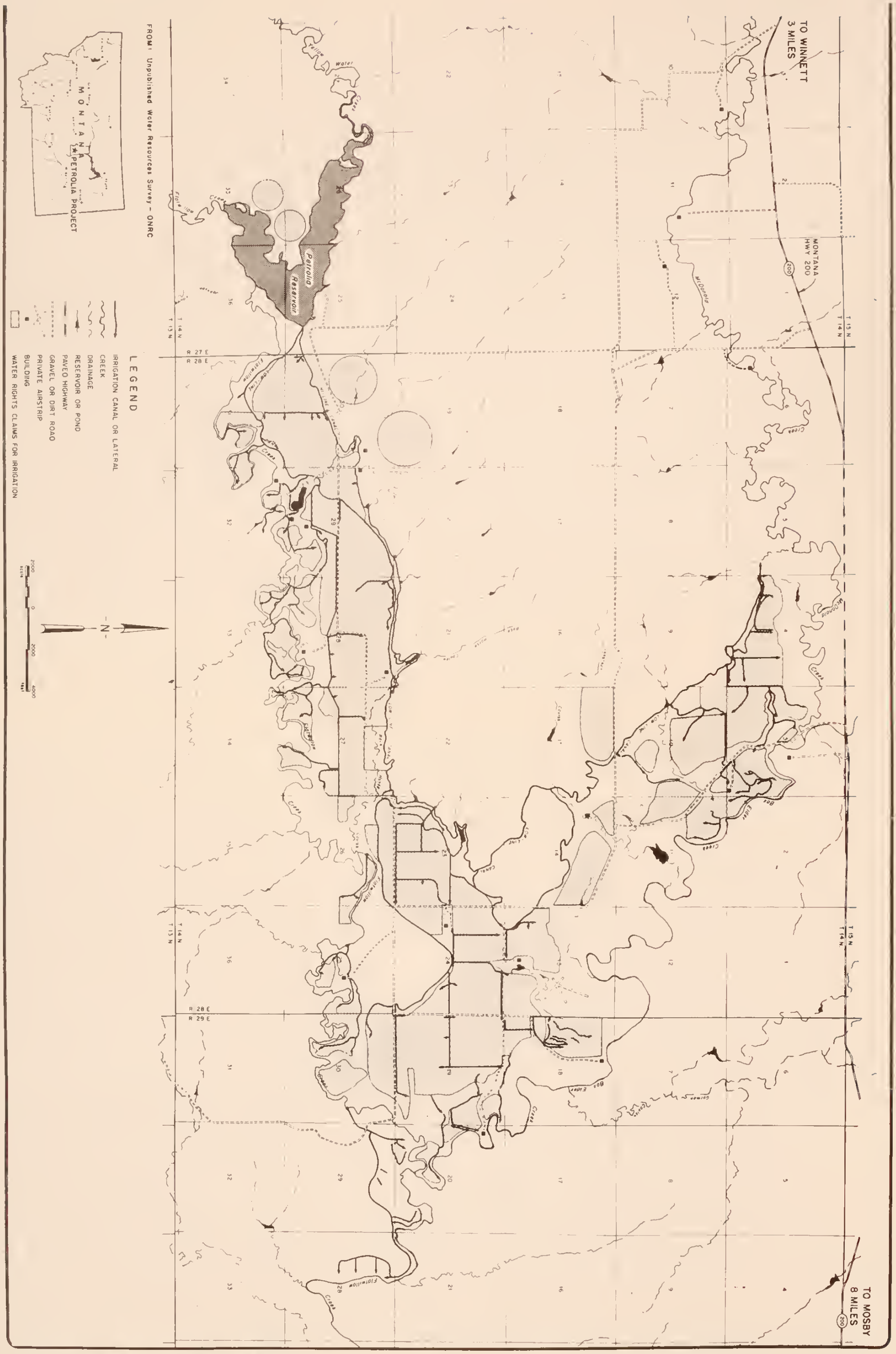


FIGURE 4.2

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PETROLIA DAM
WATER RIGHTS CLAIM MAP

Lands below Petrolia with duplicate direct flow rights from Flatwillow Creek and either McDonald Creek or Box Elder Creek were assumed to be served from McDonald or Box Elder Creek, Petrolia project return flows, and reservoir spills. The same was assumed for lands served by diversions below the confluence of Box Elder Creek and Flatwillow Creek.

Table 4.2 gives a summary of the irrigated lands divided into the priority date and point of diversion classifications shown on Figure 4.1.

NET IRRIGATION REQUIREMENT

The SCS Irrigation Guide was used to estimate net irrigation requirements for the lands in the Flatwillow Creek Basin (SCS, 1970). According to the SCS Lewistown Office, approximately 95% of the cropping above Petrolia Dam is in alfalfa, and 5% is in spring grains (SCS, phone conversation, 1985).

Below Petrolia Reservoir, the cropping pattern was determined from a 1985 survey conducted by an economic consultant (AMEC, 1985) to be 46% alfalfa, 12% spring grains, and 42% grass. According to landowners below Petrolia, no irrigation occurs in April, September, or October. Net irrigation requirement from the SCS Irrigation Guide for these months was therefore neglected.

The combined net irrigation requirement for each cropping pattern was computed as the weighted sum of the net irrigation requirements of the components. The results of this analysis are given in Table 4.3.

TABLE 4.2

IRRIGATED LANDS IN THE FLATWILLOW CREEK BASIN

Diversion Source	Priority Date	Type	Acres
Yellow Water Cr. above Yellow Water Res.	Pre-1935	Direct Flow	359
Yellow Water Cr. above Yellow Water Res.	Pre-1950	Direct Flow	205
Yellow Water Crk. below Yellow Water Res.	1935	Storage	1455
All drainages above Petrolia Res. except Yellow Water	Pre-1950	Direct Flow	11107
All drainages above Petrolia Res. except Yellow Water	Post-1950	Direct Flow	1403
Flatwillow Crk. below Petrolia Res.	1950	Storage	4890
Flatwillow Crk. below Petrolia Res.	Pre-1950	Direct Flow	165

TABLE 4.3

NET IRRIGATION REQUIREMENT

Month	Net Irrigation Requirement (ft)	
	Lands Above Petrolia Res.	Lands Below Petrolia Res.
May	0.195	0.174
June	0.291	0.264
July	0.515	0.471
August	0.409	0.354
September	0.171	
TOTAL	1.581 ft	1.263 ft

EFFICIENCIES

On the recommendation of the SCS Lewistown Office, a field efficiency of 40% and a conveyance efficiency of 70% were used (SCS, phone conversation, 1985). The field efficiency

reflects a majority of graded border flood irrigation practices. The overall irrigation efficiency is 40% x 70% or 28%. The irrigation efficiency in the late irrigation season months of August and September was raised to 50% to reflect higher efficiencies due to better water management during low streamflow periods.

RETURN FLOW

Several return flow patterns were evaluated and are summarized in Table 4.4. Pattern 1 was selected as being most representative of conditions in the basin for the following reasons:

1) Irrigation is performed on gravel terraces with shallow depths to bedrock and high hydraulic conductivity. These conditions indicate return flow is collected in a short period of time.

2) The modeling studies show more reasonable results when using return flow Pattern 1 when comparing the natural flow estimates between the two gages of interest.

TABLE 4.4

RETURN FLOW PATTERNS

Month	% of Return Flow		
	Pattern 1	Pattern 2	Pattern 3
1st[1/]	50	50	50
2nd	35	28	15
3rd	15	13	13
4th	--	1	8
5th	--	1	4
6th	--	1	3
7th	--	1	2
8th	--	1	1
9th	--	1	1
10th	--	1	1
11th	--	1	1
12th	--	1	1

1/ Return flow in the same month as diversion.

NON-BENEFICIAL USE

On the recommendation of the USBR for old developments with unlined ditches, a nonbeneficial use loss of 10% of diversion was selected for the area (USBR Phone Conversation, 1985).

RESERVOIR DATA

The elevation-capacity curve for Yellow Water Reservoir was taken from the C.O.E. Phase 1 Dam Safety Inspection (COE, 1980) and is given in Table 4.5. The elevation-capacity curve for Petrolia Reservoir was taken from a detailed survey (Streamworks, 1985) and is given in Table 4.6. Reservoir evaporation was taken from the Missouri River Basin Comprehensive Framework Study (MBIAC, 1971). The reported evaporation of 24 inches per year amounts to less than 4% of the annual inflow to Yellow Water Reservoir and less than 2% of the annual inflow to Petrolia Reservoir. These were felt to be insignificant for this level of study, so evaporation was not considered.

TABLE 4.5

YELLOW WATER ELEVATION - CAPACITY TABLE

Elevation (ft Local Datum)	Area (Ac)	Capacity (AF)	Notes
965	0	0	
968	15	50	Outlet works (dead storage)
970	24.2	61	
975	67.0	288	
980	143	813	
985	215	1710	
990	407	3260	
992.6	495	4250	Spillway crest (normal storage)
995	574	5720	
1000	729	8970	

TABLE 4.6

PETROLIA ELEVATION - CAPACITY TABLE

Elevation (Ft NGVD)	Area (Ac)	Capacity (AF)	Notes
2849.6	0	0	Outlet works (dead storage)
2855	0	0	
2865	41	162	
2870	76	457	
2875	134	990	
2880	218	1820	
2885	279	3070	
2890	355	4660	
2898.6	508	8380	Spillway crest (normal storage)
2900	535	9120	
2910	729	15400	
2920	1014	24000	

COMPUTER MODEL

The Lotus 1-2-3 computer spreadsheet (Lotus, no date) was used to form a computer model specifically for this basin. The model is set up so that columns correspond to computation points and rows correspond to months in the period of record (Appendix A and B). Both reservoirs were assumed full prior to the first month. The model was broken into two smaller models to accommodate computer storage constraints. The first model (Appendix A) simulates the operation of Yellow Water Creek, with the output of columns V and W as input for the second model (Appendix B). The second model simulates the remainder of the Flatwillow Creek basin above its confluence with Box Elder Creek. A column by column description of each model follows its output.

RESERVOIR YIELD

The purpose of the water availability study was to determine whether raising the normal pool would provide improved reservoir yield to the project lands. To make this determination, four normal pool levels were investigated:

1. Existing: Normal Pool Elevation = 2898.6 feet NGVD
2. + 2 feet: Normal Pool Elevation = 2900.6 feet NGVD
3. + 5 feet: Normal Pool Elevation = 2903.6 feet NGVD
4. +10 feet: Normal Pool Elevation = 2908.6 feet NGVD

Basin operation was simulated for each of the four cases (Appendix B). For each year, the Petrolia project diversions were totalled, then the annual project diversions were ranked in descending order and assigned a Weibull plotting position. These results, shown in columns AG and AH of the Appendix B outputs, display the change in yield provided by increased storage. Table 4.7 summarizes the results of the yield analysis. The yield shown represents water served from both direct flow and storage to project lands.

TABLE 4.7

PETROLIA RESERVOIR YIELD ANALYSIS

Normal Pool Elevation (Ft NGVD)	Normal Pool Storage (AF)	"Firm" (96.7% Chance) Yield (AF)	80% Chance Yield (AF)
2898.6	8380	10810	12129
2900.6	9470	10810	12401
2903.6	11200	10810	12401
2908.6	14400	10810	12401

*Note: A full water supply is 19,337 AF.

As can be seen from Table 4.7, the reservoir firm yield would not be improved at all for the range of normal pool levels investigated. The reason for this is the tendency of the basin toward extended drought and extensive upstream irrigation. In order for the firm yield to be improved, a tremendous increase in storage would be required to provide carryover storage to the end of an extended drought. The 80% chance yield, however, could be improved with increased storage. This is the yield that could be expected 8 out of 10 years. The improvement would be slight, even with a 10-foot increase in normal pool.

From this analysis, it is concluded that raising the normal pool would not significantly increase yield to Petrolia project lands. This conclusion was reached even though evaporation and seepage losses from the dam were not considered. Due to the extreme magnitude of the project design flood, the amount of head in the reservoir reserved for passage of floods is critical. It does not appear that the cost of raising the normal pool is warranted.

WATER RIGHTS

The water users are concerned about unauthorized use of water by junior appropriators which may adversely affect their present storage potential. The State plans to evaluate these claims in the final design; therefore a budget for this activity has been included.

CHAPTER 5

DRAINAGE

The subsurface drainage conditions on the presently irrigated lands were observed in conjunction with the arability study. No drilling or hydraulic conductivity tests were run. At the present time, few drainage problems are obvious on this project. This is due in part to the limited available water supply, but also is a function of the terrace soils. The soils are typically 2 to 3 feet deep over permeable terrace gravels which give them good internal drainage characteristics. Irrigation water that has deep-percolated naturally drains out the draws and terrace edges. Localized wet spots exist but overall high water tables do not appear to be a problem.

With higher application rates, more subsurface drainage water would enter the terrace gravels, but it is anticipated that if good management practices (i.e. lower application rates) were used, the hydraulic conductivity rates would be high enough to preclude any artificial drainage requirement. A few wet areas may develop where shallow depth to shale or sandstone forces water to the surface, but these areas should be minor in extent.

In any case, if more water were to become available due to a change in upstream irrigation practices, short frequent irrigations on these gravelly soils would result in higher efficiency, less water use, and fewer drainage problems.

CHAPTER 6

PLAN OF DEVELOPMENT

PHYSICAL PLAN

The goal of the plan of rehabilitation of Petrolia Dam is to provide structural, geotechnical, and hydrologic safety. Hydrologic safety for this dam is based on the requirement that the structure have the capacity to pass the Probable Maximum Flood (PMF) without failure.

The project plan has four major features: construction of an earthen auxiliary spillway, raising of the dam structure, rehabilitation of the existing principal spillway and construction of a fuse plug spillway. These modifications would allow the dam structure to meet dam safety criteria for stability and passage of the PMF while minimizing the cost of repair and/or additional facilities. This has been achieved by using the existing structure wherever possible.

The plan for rehabilitation also includes placing erosion protection in Johnson Coulee, repairing the outlet works gates, repairing the two irrigation canals near the dam, and the following seepage control measures: horizontal wells and collector drains on the main embankment abutments; a grout curtain cut-off wall in front of the principal spillway; and an impermeable cut-off wall extending across the auxiliary spillway to the right (south) of the principal spillway.

INVESTIGATION OF EXISTING CONDITIONS

STRUCTURAL

Currently, two structural problems exist at the project. The most serious is the existence of large voids under the spillway

slab downstream of the first construction joint (Morrison-Maierle, 1983) (HKM, December 1985). These voids are the result of erosion caused by failed water stops and high velocity seepage flows under the structure. In addition, much of the slab concrete has experienced spalling and the exit flip bucket is badly undermined. This problem could result in failure of the spillway. Meetings with the DNRC resulted in the decision that either the affected portions of the spillway be replaced or the entire spillway be abandoned and filled.

The other problem is less serious from a safety standpoint but more serious from an operational standpoint. Several components of the outlet works are in need of maintenance or replacement. One of the steel slide gates in the outlet works is badly corroded and will open only part way. The 60-inch gate located immediately below the pump house at the toe of the dam which releases flows to Flatwillow Creek should be removed, then refurbished or replaced with a new flat-back sluice gate to allow for proper operation of the outlet works. The gate operator for the 60-inch gate would also be refurbished or replaced. The other two 60-inch gates should be removed and refurbished as a maintenance measure. All of the gate stem guides and ladder mounting connections should be inspected and replaced as needed.

An analysis of the ventilation requirements of the outlet conduit using COE criteria (COE, 1964) resulted in the conclusion that the current vent is severely undersized. The existing vent is 6 inches in diameter, and the calculated required vent is a 13.2-inch pipe.

GEOTECHNICAL

The initial field drilling program and geotechnical investigation was conducted during the fall of 1984. The details of this study are reported in Petrolia Dam,

Geotechnical Investigation, (HKM, December 1985). Additional subsurface exploration was performed in January of 1986. Findings pertaining to specific rehabilitation alternatives are given in Appendix D. The results of both parts of the investigation are summarized in the following paragraphs.

The purpose of this geotechnical investigation was to provide an understanding of the physical conditions of the embankment, abutments, and foundation on which to evaluate rehabilitation alternatives for this facility.

"As built" drawings of the project are not available. However, design drawings have been obtained for this study and are on file with the DNRC in Helena, Montana (DNRC, 1985). There is no stability analysis of the embankment on file. Some instrumentation, such as piezometers and survey control points, had been established at the facility prior to this study (Morrison-Maierle, 1983). Ground water and geotechnical information presented in that report has been incorporated into this study. Six (6) open-hole piezometers were installed in the dike area of the right abutment in 1976 by the Soil Conservation Service. Ground water levels have also been monitored in these holes.

The general engineering approach began with a subsurface soils investigation to determine the physical and engineering properties of the materials. Representative soil samples were selected for laboratory testing and engineering analyses were then performed. The findings of the field and laboratory investigations and the engineering analyses were used as the basis for the evaluation and selection of rehabilitation alternatives.

The field investigation included making 13 exploration drill holes and 11 test pits. Instrumentation to monitor changes in ground water levels was installed during the field investigation. A geologic investigation was made to assist in evaluating the soils, the abutment conditions, and the impact

of a seismic event on the structure. The engineering analyses included seepage and stability studies. Static stability analyses were performed by Rollins, Brown and Gunnell, Inc. (RBG) as a check or supplement to HKM's work. RBG also performed the drilling.

HKM's findings indicate that there is a cutoff trench extending to bedrock all the way along the base of the existing embankment. While some colluvial silt may exist near the toe or groin area of the abutments, it does not extend through the abutment. Seepage in the abutment areas is the primary result of water passing through the abutment bedrock in both abutments. Seepage through the embankment fill at the abutments appears to be minor.

A large volume of seepage is passing through the left abutment. During high pool this seepage saturates the lower groin area between the abutment and the embankment. In the past this seepage has contributed to instability in the lower irrigation canal.

When either of the two irrigation canals on the left abutment are operated, seepage from the canal saturates the canal embankment and abutment area. Two horizontal drains were installed in the left abutment during this investigation to evaluate their potential for seepage control. These horizontal drains are functioning well. However, they do not operate until the reservoir pool is within about 10 feet of the normal pool level. Seepage continues to exit on the abutment below these existing horizontal drains.

Seepage through the embankment and its foundation does not appear to be a problem. Piezometer readings indicate the phreatic surface through the embankment is low and seepage volumes and pore pressure are controlled in the foundation.

There is some seepage through the right abutment. During high pool conditions, minor amounts of seepage surface at the lower groin area of this abutment. The right abutment is identified in this report as the area where the main embankment joins the natural rise adjacent to the valley floor. The embankment beyond this area is identified as the dike.

Seepage in the dike area is generally controlled by a cutoff trench constructed into bedrock. From the construction notes and original plans, it appears that this cutoff extends from the right abutment area to the principal spillway.

The potential for seepage through the natural sandstone under the principal spillway is very high. The exploration logs indicate that there is a highly fractured zone of sandstone underlying this structure. Permeabilities range from 780 to 1600 feet per year. Calculations indicate seepage through this area is excessive and should be controlled.

The results of the static stability analysis indicate the factors of safety for the existing structure at maximum section are below the recommended guidelines (COE, 1975) for the downstream slope with steady seepage conditions. The calculated factor of safety is 1.4 while the recommended factor of safety is 1.5 for the strength parameters used. The factor of safety for the upstream slope under sudden drawdown conditions is 1.29, which satisfies the recommended guideline of 1.20 (COE, 1975).

HYDROLOGIC

There were three levels of concern in this preliminary design which influenced the selection of hydrologic design criteria. First, the principal spillway must be redesigned so that it could accommodate the routed 100-year flood without damage.

Secondly, it is desirable for the principal and auxiliary spillways to be capable of safely passing the 500-year flood with minor damage. Thirdly, the project must be capable of passing the PMF with freeboard. Use of the PMF was dictated by the significant size of the dam and the expected consequences of failure including possible loss of life and the potential for extensive economic losses (CSED, 1983).

The 100-year flood and PMF were reported in the hydrology report (HKM, June 1985). The 100-year flood was altered slightly for this report by using a greater computation time step. This resulted in a more accurate hydrograph due to a more complete unit hydrograph. The 500-year flood was estimated in the following manner.

Flood magnitudes estimated from empirical equations (Parrett and Omang, 1981) for the Petrolia drainage basin, excluding the area above Yellow Water Reservoir, were plotted on a log probability scale. The area above Yellow Water was excluded to provide an unregulated basin as required for adequacy of the empirical relations. A curve was fit to the plot and the 500-year flood peak extrapolated. The 500-year runoff was then assumed to be the result of a multiple of the 100-year storm, since no empirical methods exist for this region to formulate a 500-year storm. The 100-year rainfall runoff ordinates were multiplied by 1.83 for each subbasin in the HEC-1 model (COE, 1981) to give a combined runoff equal to the extrapolated 500-year runoff. The drainage above Yellow Water Reservoir was then added back into the model with the same runoff multiplier to give the complete basin hydrograph. This procedure is similar to that used for formulation of the 100-year flood in the hydrology report (HKM, June 1985).

The three Petrolia Reservoir inflow hydrographs are given in Tables 6.1, 6.2, and 6.3.

The present spillway has the capacity to pass the 100-year flood with approximately 0.8 feet of freeboard. The spillway falls far short of passing the PMF, or even the 500-year flood. Additional spillway capacity must be added to the project to pass the balance of the PMF. As stated in the structural section, the existing spillway must also be repaired or replaced to avoid failure during more frequent spills.

REHABILITATION ALTERNATIVES

Rehabilitation plan alternatives were formulated to bring the dam into compliance with the shortfalls discussed in the previous sections.

ELEMENTS COMMON TO ALL ALTERNATIVES

The rehabilitation plan for Petrolia Dam includes several elements that are common to all alternatives. These are included in the following paragraphs.

Seepage Control

Seepage controls are needed in the following areas:

- Left abutment
- Right abutment
- Principal spillway

Seepage controls on the left abutment are designed to reduce the potential for saturating the embankment and natural left abutment soils. Four (4) additional horizontal drains are proposed to further control seepage deep in the left abutment.

TABLE 6.1
PETROLIA RESERVOIR INFLOW: 100-YEAR FLOOD

Time (Hr)	Runoff (cfs)	Time (Hr)	Runoff (cfs)	Time (Hr)	Runoff (cfs)
0	43	28	10471	56	3108
1	42	29	10052	57	2981
2	42	30	9643	58	2860
3	41	31	9246	59	2746
4	41	32	8861	60	2636
5	41	33	8488	61	2532
6	41	34	8129	62	2433
7	40	35	7782	63	2337
8	40	36	7448	64	2246
9	40	37	7127	65	2159
10	40	38	6819	66	2079
11	40	39	6524	67	2002
12	94	40	6241	68	1927
13	766	41	5971	69	1855
14	2029	42	5711	70	1787
15	3757	43	5463	71	1720
16	5398	44	5232	72	1656
17	7143	45	5010	73	1595
18	8307	46	4796	74	1536
19	9056	47	4591	75	1479
20	9768	48	4395	76	1425
21	10186	49	4207	77	1372
22	10402	50	4027	78	1322
23	10720	51	3855	79	1274
24	11055	52	3691	80	1227
25	11284	53	3534	81	1182
26	11280	54	3384	82	1140
27	10901	55	3242	83	1098

TABLE 6.2
PETROLIA RESERVOIR INFLOW: 500-YEAR FLOOD

Time (Hr)	Runoff (cfs)	Time (Hr)	Runoff (cfs)
0	72	25	13678
1	172	26	13077
2	1401	27	12503
3	3713	28	11956
4	6885	29	11432
5	9907	30	10932
6	13146	31	10456
7	15430	32	10007
8	16935	33	9575
9	18680	34	9161
10	19096	35	8765
11	19485	36	8386
12	20034	37	8023
13	20619	38	7677
14	21008	39	7347
15	20966	40	7032
16	20233	41	6732
17	19406	42	6445
18	18599	43	6178
19	17817	44	5921
20	17061	45	5674
21	16331	46	5437
22	15630	47	5209
23	14954	48	4992
24	14303	49	4784

TABLE 6.3
PETROLIA DAM
PMF RUNOFF HYDROGRAPH

Time (Hr)	Runoff (cfs)	Time (Hr)	Runoff (cfs)	Time (Hr)	Runoff (cfs)	Time (Hr)	Runoff (cfs)
0	43	25	128912	50	43243	75	15301
1	42	26	128149	51	41378	76	14710
2	42	27	126616	52	39605	77	14144
3	41	28	123598	53	37916	78	13601
4	41	29	118890	54	36321	79	13081
5	41	30	113580	55	34796	80	12582
6	64	31	108222	56	33336	81	12059
7	149	32	102990	57	31927	82	11557
8	341	33	97940	58	30577	83	11033
9	711	34	93196	59	29293	84	10489
10	1334	35	88643	60	28084	85	9923
11	2296	36	84305	61	26941	86	9338
12	3658	37	80187	62	25848	87	8691
13	5651	38	76294	63	24803	88	7731
14	9072	39	72638	64	23805	89	5369
15	16274	40	69192	65	22850	90	2103
16	27872	41	65935	66	21937	91	1225
17	43387	42	62857	67	21064	92	800
18	63294	43	59855	68	20229	93	559
19	100796	44	56943	69	19430	94	370
20	124119	45	54268	70	18665	95	229
21	131336	46	51786	71	17933	96	136
22	132607	47	49455	72	17232	97	89
23	131576	48	47263	73	16561	98	43
24	129859	49	45202	74	15918	99	43
						100	43
						101	43

These drains would be located lower on the abutment than the two existing drains described in the Investigation of Existing Conditions section.

A blanket filter would be placed in the groin areas to collect seepage passing through both abutments. The filters would be designed to reduce the potential for piping and also to serve as a drain medium to remove seepage from the abutments. Collector drain pipes would be included in the drain medium. Collected seepage would be piped to the stream channel as shown on Appendix C.1 and C.5.

Seepage control is needed in the irrigation canals to reduce seepage through the floor and banks. It is proposed to excavate the canal banks and floor of both canals for a distance of 150 feet and replace them with a well compacted engineered fill. A two-foot-thick impervious clay liner would be placed along the wetted perimeter as shown on Appendix C.3.

Seepage into the principal spillway through the natural bedrock in front of the spillway would be controlled by a grout cutoff curtain constructed in the sandstone bedrock. This would include three rows of grout with an average hole depth of 50 feet. The effective spacing would be 5 feet. The length of the curtain would be 165 feet.

Stability

The static stability of the embankment could be brought within the guidelines by constructing a small berm at the downstream toe of the dam, or by adding high strength fill on the

downstream slope of the dam. The upstream slope would be flattened to 2.5H:1V above the normal pool elevation (2898.6 feet NGVD) and 3H:1V below.

On the left end of the dam the embankment alignment would be adjusted upstream to avoid altering the irrigation outlet system. In this area a high strength gravel fill would be placed on the upstream face. The downstream slope would not be altered in this area. It is assumed that stability of the downstream face would be adequate with the berm effect of the canal, three dimensional stabilizing effect of the abutment, and the addition of the horizontal drains and the blanket filter.

Johnson Coulee Erosion Control

Erosion in Johnson Coulee is currently progressing toward the dam. The erosion areas are vertical weathered shale banks overlaying competent shale where annual flood flows in Johnson Coulee erode away the talus slope at the bottom of the bank, causing instability in the vertical portion of the bank. As the banks consist of competent shale, large flood flows in Johnson Coulee from spillways upstream will not cause catastrophic erosion. However, the continued annual erosion should be addressed. This can be accomplished by either designating the affected areas as waste sites for the project or placing riprapped dikes to divert common flows away from the bank. The first alternative was found to be the most cost effective, and is the recommended action.

Johnson Coulee Diversion

The possibility of augmenting reservoir inflows by diverting water into the reservoir from Johnson Coulee was evaluated. Additional inflows would provide more water for irrigation,

thus increasing project benefits. An analysis of this option found that it was not economical, due to high costs of diversion structure and canal for little additional water that would be made available by this diversion. This feature was therefore not included in the recommended rehabilitation plan.

Outlet Works Rehabilitation

Three 60-inch gates and miscellaneous hardware in the outlet works require repair or replacement for all alternatives as described in the Investigation of Existing Conditions section of this chapter.

An air vent must be drilled through the embankment into the outlet conduit downstream of the operating gate. The finished product would be a 12-inch diameter steel pipe approximately 6 feet downstream of the outlet tower.

FLOOD CONTROL ALTERNATIVES

The bulk of the rehabilitation plan formulation centered around providing adequate storage and spillway capacity to route the PMF flows through the reservoir. Because the present spillway is structurally unsound, all the options considered included repairing or replacing the principal spillway. The cost of one concrete spillway large enough to pass the PMF would be prohibitive. Therefore, evaluations were made using concrete spillways to carry more frequent flood flows with various configurations of earthen auxiliary spillways to operate during the less frequent flood flows. Earth excavated for the auxiliary spillway could be placed on the existing embankment to raise the crest elevation. This would help decrease the spillway requirements by allowing for increased flow depth before infringing on the allowable freeboard.

Required freeboard for the project was computed based on an effective fetch of 0.92 miles, an average reservoir depth of 25 feet over the fetch, and a design wind of 59 mph with a 15.1 minute duration (COE, 1976). For a 2.5H:1V riprap slope, the maximum runup was computed to be 3.8 feet. The wind setup was computed to be 0.2 feet, so required freeboard is 4.0 feet.

Areas to both sides of the existing spillway are good locations for auxiliary spillways. To the right of the existing spillway is a large flat area that could be excavated to provide a spillway channel. There is a hill that restricts this spillway width to approximately 1200 feet. To the left of the existing spillway, the dike could be lowered to provide an auxiliary spillway. This area is also restricted in width to approximately 1100 feet to avoid areas where Johnson Coulee is presently eroding toward the dam. Both auxiliary spillway locations would require erosion protection along the crest to prevent flood flows from eroding the spillway channel and releasing additional flows during floods.

Numerous layouts for the principal and auxiliary spillways and various dam crest elevations were considered to develop the most economical rehabilitation plan. The proposed plan evolved through comparison of different options at an appraisal grade level followed by more detailed studies of the more economical options. The following discussion summarizes the results of these studies.

New concrete principal spillways ranging in width from 97 to 1025 feet wide were considered. Both ogee and labyrinth crest controls were considered. The labyrinth crest was eliminated early in the process due to excessive labyrinth wall thicknesses to combat high ice loads. Both conventional concrete and soil cement were considered for use as a principal spillway construction material. In order to be cost

competitive, the soil cement spillway could not have a facing of conventional concrete, so the wearing surface would be soil cement. The two concepts were found to yield comparable costs; however superior hydraulics, serviceability, and aesthetics resulted in selection of conventional concrete as the principal spillway construction material.

Rehabilitation of the existing spillway, utilizing the existing crest, was also evaluated as a principal spillway.

Auxiliary spillways were sized to operate only during floods greater than the 100-year flood. Auxiliary spillways ranging in width from 400 to 2000 feet and crest elevations from 2900.6 to 2907.6 were considered. Several types of erosion control for the crest were considered, including riprap, plastic and metal surface mesh, surface paving, and buried walls constructed of geogrid, soil cement, and conventional reinforced concrete. These methods were evaluated on a cost and reliability basis. The soil cement wall was selected as the best construction material.

Due to the extremely high peak reservoir inflow of the PMF (132,600 cfs) the dam crest would have to be raised for flood surcharge head on the spillways. Four elevations were investigated in an effort to bracket the most cost effective elevation: 2910, 2912, 2915, and 2920 feet NGVD. The best elevations were found to be in the 2912 to 2915 range.

The appraisal level cost comparison resulted in elimination of all alternatives with dam crests at elevations 2910 and 2920 feet NGVD. The best alternatives utilized a dam crest elevation of 2915 feet NGVD, due to the significantly smaller spillway requirements providing savings in excess of the increased dam fill. The best alternatives were then further refined to arrive at the final rehabilitation plan.

For alternatives with a dam crest at 2915 feet NGVD, a major cost was placement of fill on the main dam. Since the top 4 feet only provide freeboard, cost savings could be realized by providing fill only up to the maximum water surface and utilizing a splash barrier for wave protection. Piled riprap, precast concrete blocks, gabions, and a reinforced concrete wall were investigated for this purpose. The reinforced concrete wall was found to be the best solution to satisfy roadway constraints and minimize cost.

Runup on a vertical wall is described in the Shore Protection Manual (COE, 1973). For a water surface at the base of the wall and a 10H:1V embankment slope, the maximum runup is computed to be 2.7 feet. For a 2.5H:1V embankment slope, it is anticipated that the wave runup would be slightly higher. Combining runup and setup on a vertical wall, the freeboard requirement is estimated to be 3.0 feet.

The use of a fuse plug in the auxiliary spillway was analyzed as a cost saving measure. A fuse plug refers to controlled erosion of a portion of embankment placed in an auxiliary spillway. Failure of the fuse plug would only occur during extreme flood events (floods in excess of the 500-year flood were used for this project). A carefully constructed fuse plug can be expected to fail in a controlled manner. An overtopping depth of 1 foot can be expected to precipitate failure of a fuse plug (Engels, 1985). Lateral growth rates of fuse plugs at each boundary can be expected to vary from 1.4 feet/minute for well graded sand and gravel to 5.6 feet/minute for a uniform gravel (Engels, 1985). A fuse plug offers cost savings by reducing the required capacity of the other spillways and the amount that the dam crest must be raised. The main drawback of typical fuse plugs is the sudden increase in spillway outflow when they breach. The downstream effects of this surge were accommodated in the design.

A method of preventing the sudden surge downstream was investigated. This consisted of installation of the fuse plug downstream of a control crest termed here a "guard dike". As long as the fuse plug does not back up water over the guard dike, control of reservoir outflows will remain with the guard dike.

The two alternatives selected for this report are discussed in the following paragraphs. The first is an arrangement with a fuse plug exposed to the reservoir. The second contains a fuse plug downstream of a guard dike.

Fuse Plug Alternative

This alternative includes the following flood control components:

- Rehabilitation of the principal spillway
- Construction of an earth auxiliary spillway to the right of the existing spillway
- Construction of a fuse plug spillway to the left of the existing spillway
- Raising the dam to provide for a peak reservoir elevation of 2912.0 feet NGVD, with freeboard.

In utilizing a fuse plug immediately on the boundary of the reservoir, essentially all of the available flood surcharge head can be used to pass relatively frequent floods. A small amount must be reserved to initiate failure of the fuse plug. For this arrangement, the most economical principal spillway would be obtained through rehabilitation of the existing spillway. The 100-year flood could be routed through this spillway alone with a maximum pool elevation of 2907.6 feet NGVD. This elevation was selected for the crest of an auxiliary spillway located to the right of the existing spillway. Together the principal and auxiliary spillways could

route the 500-year flood with a maximum pool elevation of 2909.5 feet NGVD. This elevation was selected for the crest of a fuse plug to the left of the existing spillway. With some minor grading, the existing dike would have a crest elevation of 2909.5 feet NGVD. Several sections of the dike would be replaced with select materials to insure initiation of failure. After breach of the entire fuse plug, the three spillways would route the PMF with a maximum pool elevation of 2911.8 feet NGVD. The top of fill on the main portion of the dam would be at elevation 2912 feet NGVD and a concrete splash wall would provide freeboard to elevation 2915 feet NGVD.

The impacts downstream from a fuse plug failure would be greatest during a flood just large enough to breach the fuse plug, that is, a flood equal to 1.84 times the 500-year flood. The recurrence interval of this event is extremely large and beyond reasonable extrapolation. The fuse plug was assumed to require an overtopping head of 1.0 foot to initiate failure and 1.5 hours to completely disappear. The earth beneath the fuse plug is an erodible sandy gravel. It is anticipated that the fuse plug failure would continue down through the natural sandy gravel material to bedrock. Based on failures of dams constructed of similar materials, 4 hours is a reasonable estimate of the failure time of the natural material down to bedrock. As a measure of added conservatism, the fuse plug was assumed to fail in only 0.5 hour for downstream damage estimates. Comparison of the maximum flood stages downstream was made between the aforementioned flood without the dam's influence and with the effects of the fuse plug and foundation gravel failure. The increase in stage at downstream dwelling locations is given in Table 6.4.

TABLE 6.4

1.84 x 500-yr Flood Routed Through Reservoir

River Mile Index	Water Surface Without Dam (ft. NGVD)	Water Surface With Fuse Plug Failure*** (ft. NGVD)	Increase In Stage (ft.)	House Foundation Elevation (ft. NGVD)
29.7	2822.2	2827.0	4.8	2829
29.5**	2814.0	2817.0	3.0	2805,2811,2813
27.8	2782.9	2784.3	1.4	2792
22.2	2718.3	2719.7	1.4	2720
17.6**	2664.2	2665.2	1.0	2680
14.6	2646.2	2647.7	1.5	2670
4.5	2602.6	2604.3	1.7	
84.0*	2557.9	2558.8	0.9	2575,2558
78.2*	2534.3	2535.2	0.9	
74.3*	2510.8	2512.0	1.2	

* On Musselshell River

** Interpolated Section

*** 1/2 hr. Fuse Plug Failure Followed by 4 hr. Failure of 2nd Auxiliary Spillway Foundation

The only two locations of concern during this event are at river mile 29.5 and 84.0. At river mile 29.5, all three dwellings would be partially inundated by the flood even without the dam. The SCS defines a life threatening flood as one in which the product of the depth and velocity is greater than or equal to 5 or 7 (SCS, 1980). The velocity for the peak flow without the dam was computed to be 16.6 fps and the water depths were 1.0 feet, 3.0 feet, and 9.0 feet at the houses. The product of velocity and depth for all three houses was greater than 7, so it can be concluded that a life threatening situation exists for this flood, regardless of the existence of the dam. At river mile 84.0, the velocity and depth at the house in question were computed to be 1.9 fps and 0.8 feet respectively as a result of the fuse plug breach. This is not considered a life threatening situation.

It can be concluded that the fuse plug does not increase the potential for loss of life.

For these reasons as well as economy of the design, this alternative is being presented as the proposed alternative and is described in greater detail in the section of this chapter titled "Proposed Rehabilitation Plan".

Guard Dike Alternative

This alternative includes the following flood control components:

- Construction of a guard dike drop structure as the primary flood control element to the left of the existing spillway
- Construction of a new principal spillway downstream of the guard dike for frequent floods
- Construction of a fuse plug downstream of the guard dike for rare floods

- Construction of an auxiliary spillway to the right of the existing spillway
- Raising the dam to provide for a peak reservoir elevation of 2912.0 feet NGVD, with freeboard.

In this arrangement, the guard dike (to the left of the existing spillway) would act as a relatively long and shallow drop structure controlling the normal pool of the reservoir at 2898.6 feet NGVD. Flood flows passing over the guard dike would drop into a ponded area bordered by dikes. One section of dike would be a fuse plug. Frequent floods would be directed into a new concrete principal spillway which would discharge safely into Johnson Coulee below. The 100-year flood could be routed entirely with this system with a maximum reservoir elevation of 2902.2 feet NGVD. The maximum water surface elevation downstream of the guard dike (in the small pond) would be 2899.5 feet NGVD. The fuse plug crest elevation was set 1.3 feet higher at elevation 2900.8 feet NGVD to allow freeboard during the 100-year flood. The 1.3 feet was based on wave runup calculations for the small pond similar to those made for dam freeboard.

An earth auxiliary spillway to the right of the existing spillway would be required in addition to the guard dike to pass the PMF. This spillway would operate for floods greater than the 100-year flood, so its crest was set at 2902.2 feet NGVD.

The fuse plug downstream of the guard dike would not wash out until total outflow from the project reached approximately 28% of the peak PMF discharge (38,000 cfs). This level is not of any significance from a safety standpoint, since only the small storage from the pond would be released. After failure of the fuse plug, discharge over the guard dike could continue to rise

without downstream effects. Up to this level, even though the guard dike discharge would be channelled into the principal spillway, no backwater effects would occur on the guard dike.

The existing spillway would be abandoned and buried for this alternative.

Relative to downstream effects, this alternative presents less risk to property and equal risk to life as the fuse plug alternative, although not without cost. Due primarily to the higher construction cost, this arrangement is presented in this report as an alternative design. Cost information for the guard dike alternative is given in Table 7.4. A plan and profile is shown on Appendix C.5.

PROPOSED REHABILITATION PLAN

It is proposed that the dam be raised to an elevation that would allow a maximum reservoir water surface elevation during the PMF of 2912 feet NGVD. This would consist of adding fill to elevation 2912 feet NGVD over the main dam and satisfying freeboard with a 3-foot-high concrete splash wall. In the vicinity of the outlet works, the fill would be placed on the upstream face of the dam to minimize modifications to outlet works structures on the downstream face. To the right of the outlet works (looking downstream), the dam crest would be gradually transitioned to a configuration with fill on the downstream face. The crest width for this portion of the dam would be 21 feet. Appendix C.1 and C.2 reflect these proposed modifications.

Beginning with Station 16+00 (Appendix C.1), the dam crest would be transitioned to a top of fill elevation of 2916 feet NGVD without the splash wall. For stations greater than 16+00, the additional earthwork required to satisfy freeboard with fill (4 feet on a 2.5H:1V riprap slope) would cost less than

the splash wall. Within the fill transition from elevation 2912 to 2916, the roadway along the top of the dam would begin a descent down the upstream face of the dam to the natural ground where it would cross in front of all of the spillways. As is presently the case, access to the right of the principal spillway during periods of high reservoir elevations would be limited to foot traffic. The dam crest width for stations greater than 16+00 would be 22 feet.

For the entire structure, high strength gravel soil would be used as the main fill material. The upstream slope would be 3H:1V below the normal pool elevation of 2898.6 feet NGVD and 2.5H:1V above. The downstream slope would be 2H:1V.

Four new horizontal wells would be drilled in the left abutment. Two holes would be drilled approximately six feet above the top of the existing conduit and two holes would be drilled approximately eleven feet above the conduit. Horizontal holes in the right abutment do not appear to be necessary (Appendix C.1).

Blanket drain filters would be constructed in the downstream groin areas of each abutment. These would consist of two-foot-thick layers of drain gravel placed on natural material at the contact between the embankment and the natural abutment. Drainfill would be processed on site from the gravel excavated from the auxiliary spillway area. Collector pipes would be installed in the blanket drains and directed to the downstream toe area to be discharged (Appendix C.1).

The first 150 feet of both the low line and high line canals would be removed and rebuilt. Canal banks would be replaced with well compacted soils. The wetted perimeter of the two

canals would consist of a two-foot-thick layer of impervious material. A minimum thickness of one foot would be required in areas where bedrock is encountered (Appendix C.1).

In the proposed design the original drain system would be left as it is to operate as a control system for seepage through the foundation and embankment. The original drain system would be excavated on the lower end and cleaned during final construction (Appendix C.1).

There are three components of the outlet works rehabilitation for the proposed project. The gate house walls must be raised to accommodate the increased flood levels. Three slide gates and miscellaneous hardware would be replaced or refurbished, as described in the Investigation of Existing Conditions section of this chapter. A 12-inch air vent would be drilled through the embankment into the outlet conduit about 6 feet downstream of the outlet tower to prevent cavitation on the operating gate.

A concrete collar would be cast around the control tower to act as a foundation for new concrete walls that would hold water from the wet well during a large flood. The top of the concrete would be at elevation 2912 feet NGVD. The concrete walls would be topped with wooden walls and a wood roof to allow for servicing of the gates in the tower. Appendix C.3 shows these modifications.

The existing spillway would be modified to replace damaged portions as discussed in the Investigation of Existing Conditions and to increase the capacity by raising the walls (Appendix C.4).

The proposed plan would require demolition of the entire spillway downstream of the first construction joint (downstream of the crest structure). Even though the walls downstream of

this point are in reasonably good shape, their footings would present a problem with the new lowered slab. Upstream of the first construction joint, the bridge would be removed and set aside for replacement at elevation 2916 feet NGVD. New walls would be cast inside of the existing walls to elevation 2916 (7.4 feet higher than existing). The ogee crest and chute would be reduced to 97 feet wide from the original 100 feet. The new section of chute slab would continue from the first construction joint at a 4% slope for 6.7 feet, then transition to a 40.7% slope. A 43-foot-long USBR Type III stilling basin would be added with a floor elevation of 2862.2 feet NGVD. Slab anchors would tie down the new slab and stilling basin to bedrock. An inlet grout curtain 50 feet deep and 165 feet wide would provide seepage control. A drain system would be placed in a 1-foot-thick gravel filter layer under the slab to further control seepage (Appendix C.4).

The principal spillway walls, with the exception of the stilling basin walls, have been designed to withstand flows during the PMF without overtopping. The maximum flow in the principal spillway during the PMF would be 16,700 cfs. Tailwater in Johnson Coulee would drown out the hydraulic jump for this flow by about 12 feet, overtopping the stilling basin walls by about 11.5 feet. The low velocities in the tailwatr area would not create serious scour problems in the bedrock around the principal spillway, so it is not necessary to extend the walls above the water surface. The stilling basin has been designed for the 100-year peak flow. The routed 100-year flood would have a peak flow of 9,300 cfs and a peak reservoir stage of 2907.6 feet NGVD. For flows greater than 9300 cfs, stilling action would not be complete and the hydraulic jump would tend to sweep out of the stilling basin or be drowned out, depending on the flows in the auxiliary spillways. Some scour at the end

sill could be expected during these events; however, the bedrock foundation would limit this action and damage would be minor. The routed 500-year flood would have a peak flow in the principal spillway of 12,300 cfs.

The proposed auxiliary spillway would be an excavated earthen spillway to the right of the principal spillway (Appendix C.1 and C.3). The crest elevation was set at the 100-year flood reservoir pool elevation of 2907.6 feet NGVD. The inlet section would be 2 feet lower than the crest to decrease inlet losses. A buried soil cement wall would provide erosion control at the crest during operation for all flows. The wall has been designed to withstand loss of earth support downstream by erosion without overturning. Downstream of the crest a slope of 46H:1V would maintain supercritical flow for discharges greater than or equal to that occurring in a 500-year flood (8500 cfs). As a measure of conservatism, a Manning's roughness of 0.04 was used for this calculation, even though the actual roughness was estimated to be 0.027. The crest length would be 1200 feet with 3H:1V side slopes. The auxiliary spillway rating curve was developed using an energy balance between the crest and the reservoir pool. An inlet loss coefficient of 0.22 applied to the difference in velocity heads was verified using a step backwater computer model (COE, September 1982). The 500-year flood was routed to a peak reservoir water surface elevation of 2909.5 feet NGVD. Velocities downstream of the crest would be approximately 6 feet per second under a normal depth of 1.16 feet. Headcutting and flow concentration would be likely, increasing velocities and depths. The soil cement crest control was designed to arrest the headcutting process from moving into the reservoir. The PMF would force approximately 31,000 cfs through the auxiliary spillway with a maximum pool elevation of 2911.8 feet

NGVD. A significant amount of damage is expected to occur in the auxiliary spillway during this event; however, safety of the dam would be ensured by the crest control structure. Table 6.5 gives the rating curves of the principal and auxiliary spillways.

A 1124 foot section of dike to the left of the principal spillway would act as a fuse plug under the proposed plan (Appendix C.1 and C.3). The dike would be regraded to a 500-year reservoir water surface elevation of 2909.5 feet NGVD. Four sections of the dike would be removed and replaced with select materials using state-of-the-art fuse plug design. The four pilot sections would wash out first, leaving full depth channels with greater power to wash out the remaining dike.

The pilot channels were assumed to begin to fail when the reservoir elevation reaches 2910.5, and would be completely gone in 0.5 hour. The remaining fuse plug section would require an additional 1.0 hour to be consumed. The pilot channels would have a bottom width of 120 feet each with side slopes of 2H:1V, with the exception that the end channels would have one side of 3H:1V adjacent to the edge of the fuse plug. The entire fuse plug would have a bottom width of 1070 feet (perpendicular to the flow).

During the PMF, the discharge through the fuse plug would reach 84,600 cfs if the natural material under the fuse plug were to remain. From a routing standpoint, this fuse plug operation scenario would provide for passage of the PMF with freeboard. It is anticipated that the tremendous erosive power of the discharge would lower the entire channel to bedrock (approximately elevation 2890 feet NGVD). Routings simulating this condition indicate that damages downstream attributable to the release of storage would be minor (see discussion in Flood Control Alternatives).

TABLE 6.5
RATING CURVES

Reservoir Water Surface Elevation (ft NGVD)	Principal Spillway Discharge (cfs)	Auxiliary Spillway Discharge (cfs)	Fuse Plug Spillway Discharge (cfs)**	Combined Discharge (cfs)
2898.6	0			0
2899.6	294			294
2900.6	867			867
2901.6	1640		0	1640
2902.6	2590		1534	4124
2903.6	3700		6694	10394
2904.6	4940		13896	18836
2905.6	6260		22691	28951
2906.6	7660		32846	40506
2907.6	9180	0	44217	53397
2908.6	10800	3340	56698	70838
2909.6	12400	9450	70214	92064
2910.6	14200	17400	84703	116303
2912.0	16700	31000	106531	154231

** After fuse plug washes out, assuming foundation gravel remains

The spread of fuse plug erosion into the permanent embankment would be controlled by border dikes riprapped on a 3H:1V slope (Appendix C.1).

CONSTRUCTION CONSIDERATIONS

MATERIALS

Earth Embankments

Most of the earth embankment material would be obtained from materials excavated from the auxiliary spillway. Tests on this material indicate that it has a high internal strength. Borrow sites have been located for the impervious clay core and riprap. These sites are shown on Exhibits C.1 and C.5.

Concrete

The nearest ready mix concrete plants are located in the towns of Roundup and Lewistown. Roundup is approximately 60 miles from the site and Lewistown is approximately 65 miles. The concrete splashwall could be precast in sections and hauled to the site. The remaining concrete work would be cast-in-place. It appears that there would be adequate concrete and soil cement work to justify setting up a batch plant at the construction site.

Soil Cement

The soil cement crest control wall for the auxiliary spillway would utilize local materials for aggregate. The material excavated from the trench would require minor processing to remove oversize rocks. Water would be available from the reservoir once filling began, following outlet works repairs.

WATER CONTROL

The construction period should be scheduled to begin in the fall of the year to take advantage of the low water level in the reservoir. This would also correspond to low ground water levels. Dewatering will be necessary for the placement of the stilling basin for the principal spillway, outlet works repairs, and upstream face work near the outlet works. Surface control of seepage water may also be needed for the horizontal wells installation and for stripping at the toe of the main embankment. No major water control problems are anticipated if the reservoir water level is drawn down to at least elevation 2862 feet NGVD. A temporary berm would need to be constructed around the inlet during removal and replacement of the outlet emergency gate. Each of these activities should take one day.

SITE CONDITIONS

The weather at Petrolia Dam is typical of eastern Montana. Winter weather can be severe. Due to water control and weather considerations, the construction period should be scheduled from late summer through fall. The site is remote but there are no major access limitations. Special staging requirements are not anticipated.

LABOR CONDITIONS

The labor conditions for this project would be typical of a remote rural project. The nearest towns with appreciable lodging facilities are Lewistown at 65 miles and Roundup at 60 miles. On-site lodging would have to be completely self-contained.

SPECIAL EQUIPMENT

Generally, the construction can be performed with conventional equipment. As previously mentioned, it is anticipated that a concrete batch plant will be set up at the site. A drill rig capable of drilling horizontal wells will also be required. The soil cement wall would be placed with conventional earthwork equipment in the same manner as roller compacted concrete.

CONSTRUCTION CONTRACT

The construction contract would be awarded based on conventional competitive bidding.

INSPECTION

Full-time inspection of construction activities would be required to provide quality assurance for the concrete/soil cement work and embankment placement. Inspection would also be necessary during drain construction.

ENVIRONMENTAL REQUIREMENTS

There are no special environmental controls required for the construction. Provisions would be made to protect water quality during construction, and dust control would be required. Disturbed areas would be reclaimed and reseeded upon completion of construction.

CONSTRUCTION PERIOD

Construction would be started in September of 1989 after dewatering of the reservoir to elevation 2862. Those features requiring dewatering (i.e. drains, upstream face embankment and riprap, spillway stilling basin and outlet works repair) would

be completed during the fall of 1989. The rest of the construction would proceed through the fall to winter shutdown. The majority of the construction would be finished by late spring of 1990. However, the reservoir would be allowed to fill during the March-May runoff period as any work impacted by the water levels would be complete at this time. The project would be cleaned up and closed out by September of 1990.

MISCELLANEOUS DESIGN CONSIDERATIONS

RESERVOIR SEDIMENTATION

Since local runoff through the project area is negligible, it is anticipated that reservoir sedimentation due to construction would not be a problem. Completion of the project would include reestablishment of native grass to protect against long term erosion effects.

OPERATION AND MAINTENANCE

No new operation and maintenance equipment or facilities are needed. The operation and maintenance of the dam would not substantially change due to the rehabilitation. Operation and maintenance should be performed in a manner that will ensure that safety requirements are met.

RIGHT-OF-WAY REQUIREMENTS

Additional right-of-way would be required for the auxiliary spillway located to the right of the principal spillway. This area consists of approximately 24 acres. There is also a cabin in this area that would be relocated. There are no other right-of-way acquisition requirements for this project.

DAM SAFETY REQUIREMENTS

This report addresses the findings and recommendations presented in the Phase I report (COE, 1980) and discussed in Chapter 1. As such, this report is classified as a Phase II Rehabilitation Study in the National Dam Safety Program (COE, 1975).

At present, dam safety guidelines for the State of Montana have not been finalized; however, the DNRC has suggested that all non-federal dams have a plan of rehabilitation prepared by 1990 and that the work be completed shortly thereafter (Phone Conversation, March 17, 1986).

ENVIRONMENTAL CONSIDERATIONS

Environmental considerations for the project are discussed in Chapter 10.

CONSIDERATION OF PROPOSALS FROM OTHER AGENCIES

The Montana Department of Fish, Wildlife and Parks (DFWP) maintains a regular stocking program at Petrolia Reservoir. Consideration toward this program would consist of advanced notification of anticipated construction drawdowns to allow DFWP to adjust its stocking schedule.

CHAPTER 7

ESTIMATED COSTS

ESTIMATES OF COST

Estimates of cost have been prepared for the rehabilitation of Petrolia Dam. These costs are based on the criteria and general design considerations presented in Chapter 6.

The total project cost of the proposed project based on January 1986 cost levels, plus an allowance for projected price increases, is approximately $2.9 million. This estimate includes, in addition to direct construction costs, reasonable allowances for contingencies, archeological investigations, engineering, (including preparation of the loan application report), rights-of-way, water rights, interest during construction, and Bureau of Reclamation participation. A summary of the estimated capital costs, loan obligation, and the applicant's contribution appears in Table 7.1.

PROJECTED FUTURE COST

Contracts for construction of the project would not be awarded before August 1989. On the basis of past history, the cost of construction can be expected to rise above the present level (January 1986). For this reason, an allowance of 10 percent has been included to accommodate cost escalation expected to occur between the time of preparation of the cost estimate and the award of the major construction contract. USBR construction cost (earth dams) indices from January 1983 (141) to January 1986 (140) indicate no inflation during this period. However, inflation from 1980 to 1983 was close to 5% per year. Since inflation is difficult to predict, an amount of 10% was included in this analysis.

TABLE 7.1

SUMMARY OF PROPOSED PROJECT COSTS

Total direct cost			$1,718,598
Contingencies (%)		20%	$343,720
Subtotal			$2,062,318
Project cost increase (%)		10%	$206,232
Subtotal			$2,268,549
Engineering (%)		7.50%	$170,141
Construction administration (%)		6.50%	$147,456
Subtotal			$2,586,146
Reimbursable interest during const.			$0
Rights-of-way			$6,000
Water rights			$5,000
Lender participation			
Processing of application	$15,000		
Administration of loan	$45,000		
Surveys performed	$0		$60,000
Other costs (Archeology)			$50,000
TOTAL CONSTRUCTION COST			$2,707,146
Loan application report			$224,000
TOTAL PROJECT COST			$2,931,146
Less applicant's contribution			
Rights-of-way	$6,000		
Water rights	$5,000		
Loan application report	$224,000		
Filing fee	$1,000		
State sponsored grant	$730,000		
Archeology	$50,000		
Subtotal			($1,016,000)
P.L.984 LOAN AND GRANT			$1,915,146
Loan obligation	$1,765,146		
Federal sponsored grant	$150,000		
Less lender expenditures prior to loan (- filing fee)			($14,000)
Less reimbursable interest during constr.			$0
TOTAL APPROPRIATION REQUIREMENT			$1,901,146
Less estimated lender administration of loan			($45,000)
TOTAL FUNDS TO BE ADVANCED BY LENDER			$1,856,146

LAND ACQUISITION AND RIGHTS-OF-WAY

Acquisition of an area of approximately 24 acres and the relocation of a cabin would be required for construction of an auxiliary spillway to the right of the principal spillway. All other lands including borrow areas are already included in the project.

ENGINEERING AND ADMINISTRATION

No contracts for engineering have been entered into by the DNRC or the PWUA; therefore, these costs are based on estimates. These estimates include final design, preparation of plans and specifications, field inspection, supervision of construction, and assistance in placing the facilities in operation.

In addition to the engineering, the DNRC may incur administrative costs consisting of general supervision, clerical work, contract negotiations, and other miscellaneous items involved in this phase of work. These costs have been included in the engineering and construction administration percentages to the extent that they are directly attributable to construction of the project.

The total estimated cost of 14 percent for engineering and administration has been applied to the construction cost estimates.

ESTIMATED COST OF PROJECT FACILITIES

A summary of the estimated cost of proposed project facilities is presented in Table 7.2. Details of the cost estimates for the proposed and alternate designs are included in Tables 7.3 and 7.4, respectively.

TABLE 7.2

ESTIMATED DIRECT COST OF PROPOSED PROJECT FACILITIES

Proposed Facility	Total Estimated Direct Cost
Principal Spillway	$ 547,707
1st Auxiliary Spillway (right of principal)	435,679
2nd Auxiliary Spillway (left of principal)	142,222
Embankment Enlargement	573,688
Canals	19,302
Total Direct Cost (without contingencies and cost increases)	$1,718,598

BUREAU OF RECLAMATION COST

During the design and construction of the project, the USBR would incur certain costs which the PWUA must pay. These costs cover the expenses involved in reviewing and processing the loan application, review of the design, and other costs pertinent to the administration of the loan. The overall costs have been estimated by the USBR to be $60,000.

TABLE 7.3
COST SUMMARY - FUSE PLUG ALTERNATIVE

ITEM	QUANTITY	UNIT	UNIT COST	COST
PRINCIPAL SPILLWAY				
Demolition DS. of STA 2+42.07 (original plan STA)	270.9	CY	$165.00	$44,698
Reinforced concrete	965	CY	$300.00	$289,500
Deadman for wall poured inside existing	50	LF	$50.00	$2,500
Inlet grout curtain				
Drilling	1650	LF	$6.00	$9,900
Grout pipe	1650	LF	$3.00	$4,950
Grout			LS	$9,490
Mobilization			LS	$15,000
Labor (sum of cost of drilling, grout pipe, and grout)			LS	$24,340
Slab anchors (59)				
Grout	6.1	CY	$350.00	$2,135
Drill & install	472	LF	$100.00	$47,200
Steel	1605	LB	$0.60	$963
Drainage				
Filter gravel (1' thick)	640	CY	$14.00	$8,960
Collector pipe	370	LF	$8.00	$2,960
Excavation	5060	CY	$8.00	$40,480
Backfill	3463	CY	$10.00	$34,630
Raise footbridge			LS	$10,000
TOTAL PRINCIPAL SPILLWAY				$547,707
1ST AUXILIARY SPILLWAY				
Stripping & waste (1'thick)	22084	CY	$1.75	$38,647
Unclassified excavation (no rock anticipated)	91363	CY	$1.75	$159,885
Unclassified excavation for soil cement crest	9207	CY	$3.50	$32,225
Soil cement	4479	CY	$40.00	$179,160
Compacted backfill for soil cement crest	4728	CY	$4.00	$18,912
Seeding	13.7	AC	$500.00	$6,850
TOTAL 1ST AUXILIARY SPILLWAY				$435,679
2ND AUXILIARY SPILLWAY				
Border dikes				
Stripping & waste	1023	CY	$1.75	$1,790
Unclassified excavation (no rock anticipated)	2511	CY	$1.75	$4,394
Compacted fill	5421	CY	$2.50	$13,553
Road gravel fill	98	CY	$10.00	$980
Sand & gravel filter	844	CY	$14.00	$11,816
Riprap (from new source)	2355	CY	$15.00	$35,325
Replace topsoil (1' thick)	447	CY	$2.50	$1,118

TABLE 7.3 (cont.)

ITEM	QUANTITY	UNIT	UNIT COST	COST
Fuse plug pilot sections				
Stripping & waste	786	CY	$8.00	$6,288
Strip & stockpile riprap	953	CY	$7.00	$6,671
Unclassified excavation	4417	CY	$1.75	$7,730
Erodible sand fill	3058	CY	$10.00	$30,580
Road gravel fill	344	CY	$10.00	$3,440
Sand & gravel filter fill	133	CY	$14.00	$1,862
Clay borrow & fill	1430	CY	$4.50	$6,435
Replace riprap from stockpile	953	CY	$7.00	$6,671
Place riprap from new source	238	CY	$15.00	$3,570
TOTAL 2ND AUXILIARY SPILLWAY				$142,222
EMBANKMENT				
Strip & stockpile riprap	821	CY	$7.00	$5,747
Stripping & waste (crest, downstream face, toe)	10531	CY	$8.00	$84,248
Compacted fill	36138	CY	$2.50	$90,345
Clay borrow & fill	6402	CY	$4.50	$28,809
Road gravel fill	1611	CY	$10.00	$16,110
Sand & gravel filter fill	2533	CY	$14.00	$35,462
Replace riprap from stockpile	821	CY	$7.00	$5,747
Place riprap from new source	4430	CY	$15.00	$66,450
Replace topsoil (1'thick)	9720	CY	$2.50	$24,300
Seeding	6.0	AC	$500.00	$3,000
Splash barrier	1615	LF	$88.00	$142,120
Horizontal drains	600	LF	$40.00	$24,000
Outlet works				
New concrete tower walls	5.5	CY	$300.00	$1,650
Wood building and misc. steel			LS	$2,200
Replace 60"x60" gate & operator			LS	$12,000
Refurbish two 60"x60" gates & operators			LS	$18,000
Drill and install new 12" dia air vent			LS	$13,500
TOTAL EMBANKMENT				$573,688
CANALS				
Unclassified excavation	2541	CY	$3.50	$8,894
Clay borrow & fill	496	CY	$4.50	$2,232
Compacted fill	2044	CY	$4.00	$8,176
				$19,302
MOBILIZATION (incl. in unit costs)				$0
TOTAL DIRECT COST				$1,718,598

TABLE 7.4
COST SUMMARY - GUARD DIKE ALTERNATIVE

ITEM	QUANTITY	UNIT	UNIT COST	COST
PRINCIPAL SPILLWAY				
Reinforced concrete	1426	CY	$300.00	$427,800
Slab anchors (59)				
Grout	10	CY	$350.00	$3,500
Drill & install	745	LF	$100.00	$74,500
Steel	2530	LB	$0.60	$1,518
Drainage				
Filter gravel (1' thick)	1200	CY	$14.00	$16,800
Collector pipe	500	LF	$8.00	$4,000
Soil cement	5370	CY	$40.00	$214,800
Structure excavation	16020	CY	$8.00	$128,160
Structure backfill	3400	CY	$10.00	$34,000
Stripping	17780	CY	$1.75	$31,115
Strip & stockpile riprap	830	CY	$7.00	$5,810
Unclassified excavation	64093	CY	$1.75	$112,163
Border dikes				
Stripping & waste	3540	CY	$1.75	$6,195
Compacted fill	5075	CY	$2.50	$12,688
Sand & gravel filter	1330	CY	$14.00	$18,620
Riprap (replace from stockpile)	830	CY	$7.00	$5,810
Riprap (from new source)	2508	CY	$15.00	$37,620
Impervious fill	4000	CY	$4.50	$18,000
Fuse plug				
Stripping & waste	1190	CY	$1.75	$2,083
Erodible sand fill	2214	CY	$10.00	$22,140
Sand & gravel filter	412	CY	$14.00	$5,768
Riprap (from new source)	1030	CY	$15.00	$15,450
Impervious fill	1236	CY	$4.50	$5,562
TOTAL PRINCIPAL SPILLWAY				$1,204,101
AUXILIARY SPILLWAY				
Stripping & waste (1'thick)	5560	CY	$1.75	$9,730
Unclassified excavation (no rock anticipated)	27520	CY	$1.75	$48,160
Unclassified excavation for soil cement crest	2440	CY	$3.50	$8,540
Soil cement	1560	CY	$40.00	$62,400
Compacted backfill for soil cement crest	870	CY	$4.00	$3,480
Seeding	14	AC	$500.00	$7,000
Border dikes				
Stripping & waste	180	CY	$1.75	$315
Compacted fill	395	CY	$2.50	$988
Sand & gravel filter	110	CY	$14.00	$1,540
Riprap (from new source)	275	CY	$15.00	$4,125
TOTAL AUXILIARY SPILLWAY				$146,278

TABLE 7.4 (cont.)

ITEM	QUANTITY	UNIT	UNIT COST	COST
EMBANKMENT				
Existing spillway inlet grout curtain				
Drilling	1650	LF	$6.00	$9,900
Grout pipe	1650	LF	$3.00	$4,950
Grout			LS	$9,490
Mobilization			LS	$15,000
Labor (2 x cost of drilling, grout pipe, grout)			LS	$24,340
Strip & stockpile riprap	821	CY	$7.00	$5,747
Stripping & waste (crest, downstream face, toe)	11840	CY	$3.00	$94,720
Compacted fill	52669	CY	$2.50	$131,673
Clay borrow & fill	11740	CY	$4.50	$52,830
Road gravel fill	2021	CY	$10.00	$20,210
Sand & gravel filter fill	2352	CY	$14.00	$32,928
Replace riprap from stockpile	821	CY	$7.00	$5,747
Place riprap from new source	3032	CY	$15.00	$45,480
Replace topsoil (1'thick)	9720	CY	$2.50	$24,300
Seeding	6	AC	$500.00	$3,000
Splash barrier	1615	LF	$88.00	$142,120
Horizontal drains	600	LF	$40.00	$24,000
Outlet works				
New concrete tower walls	5.5	CY	$300.00	$1,650
Wood building and misc.steel			LS	$2,200
Replace 60"x60" gate & operator			LS	$12,000
Refurbish two 60"x60" gates & operators			LS	$18,000
Drill and install new 12" dia air vent			LS	$13,500
TOTAL EMBANKMENT				$693,785
CANALS				
Unclassified excavation	2541	CY	$3.50	$8,894
Clay borrow & fill	496	CY	$4.50	$2,232
Compacted fill	2044	CY	$4.00	$8,176
				$19,302
MOBILIZATION (incl. in unit costs)				$0
TOTAL DIRECT COST				$2,063,464

REIMBURSABLE INTEREST DURING CONSTRUCTION

No water delivered by the project is to be used for urban M&I (municipal and industrial) or small-tract M&I purposes. The project would not provide irrigation water to land in ownerships in excess of 960 acres. Therefore, the applicant would not be required to pay interest during construction and reimbursable interest during construction costs are $0.

CONSTRUCTION PROGRAM

PRECONSTRUCTION

The exact program of construction for a project of this scope depends to a great extent upon the date the money becomes available. It has been assumed that the loan application would be approved, and the contract negotiation with the USBR and validation successfully completed by October 1, 1988. This optimistic schedule is obtainable with the cooperation of Congress and the USBR. Schedule delays prolong risk and increase the chance for inflation levels above those allowed in the estimate.

The design is projected to be finished, complete with approved plans and specifications by June 1, 1989, given the above schedule.

CONSTRUCTION PERIOD

Construction would be started in September of 1989 after dewatering of the reservoir to elevation 2862. Those features requiring dewatering (i.e. drains, upstream face embankment and riprap, spillway stilling basin and outlet works repair) would be completed during the fall of 1989. The rest of the construction would proceed through the fall to winter shutdown. The majority of the construction would be finished

by late spring of 1990. However, the reservoir would be allowed to fill during the March-May runoff period as any work impacted by the water levels would be complete at this time. The project would be cleaned up and closed out by September of 1990.

FEDERAL INTEREST DURING CONSTRUCTION

An estimate of federal interest during construction based on an interest rate of 11-1/8% is given in Table 7.5. This is not to be confused with the discount rate of 8-5/8% used in Table 9.4.

EXPENDITURE OF FUNDS

An estimate of the schedule for the expenditure of funds received from the federal government is shown in Table 7.6. All funds would be utilized in one fiscal year.

OPERATION, MAINTENANCE, REPLACEMENT, AND POWER (OMR&P) COSTS

The project would continue to serve 4890 irrigable acres with a full water supply of 19,337 AF in 5 out of 10 years. Project facilities would consist of a dam and reservoir and one pumping station to lift water to the High Line canal. OMR&P costs were estimated based on costs from past years. The present assessment is $3.00/AF which includes payment for DNRC and FmHA loans of $1.42/AF. This corresponds to present charges for OMR&P of $1.58/AF. PWUA has been able to operate at this funding level for a number of years and has accumulated reasonable reserves for replacement and emergency funds. For economic studies in this report, a value of $1.75/AF was assigned as the OMR&P costs. PWUA expenditures for 1984 and 1985 are presented in Table 7.7. These two years represent higher than average costs, as 1984 includes major pump overhaul expenses, and 1985 had excessive pumping expenses due to the drought year.

TABLE 7.5

FEDERAL INTEREST DURING CONSTRUCTION

Year	Appropriation	One-half of Appropriation	Summation of Prior Years Appropriation	Summation of Prior Years Interest	Amount for Computing Interest	Interest 11.125
(1)	(2)	(3)	(4)	(5)	(6)	(7)
FY1	$1,901,146.27	$950,573.14	$0.00	$0.00	$950,573.14	$105,751.26
FY2	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY3	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY4	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
FY5	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Totals	$1,901,146.27					$105,751.26

TABLE 7.6

SCHEDULE FOR EXPENDITURE OF FUNDS

Fiscal Year	Yearly %	Function	Federal Grant Funds	Federal Loan Funds	Applicant's Contributed Funds
FY1	100%	Water rights			$5,000
	100%	Engineering			$170,141
	100%	Construct. admin.			$147,456
	100%	Admin. of loan		$45,000	
	100%	Construction contracts	$150,000	$1,706,146	$412,403
FY2	0%	Water rights			$0
	0%	Engineering			$0
	0%	Construct. admin.			$0
	0%	Admin. of loan		$0	
	0%	Construction contracts	$0	$0	$0
FY3	0%	Water rights			$0
	0%	Engineering			$0
	0%	Construct. admin.			$0
	0%	Admin. of loan		$0	
	0%	Construction contracts	$0	$0	$0
FY4	0%	Water rights			$0
	0%	Engineering			$0
	0%	Construct. admin.			$0
	0%	Admin. of loan		$0	
	0%	Construction contracts	$0	$0	$0
FY5	0%	Water rights			$0
	0%	Engineering			$0
	0%	Construct. admin.			$0
	0%	Admin. of loan		$0	
	0%	Construction contracts	$0	$0	$0
TOTAL APPROPRIATION REQUIREMENT			$150,000	$1,751,146	
APPLICANT'S CONTRIBUTION (after loan approval)					$735,000

TABLE 7.7

PETROLIA WATER USERS' ASSOCIATION

Statement of Income and Expenditures
for the period from January 1 through December 1

	1984	1985
INCOME:		
Water Assessment	$29,178	$29,178
EXPENDITURE		
Wages:		
Secretary	$ 600.00	$ 600.00
Ditch Rider	5,000.00	5,000.00
Other Wages		261.00
Employee Benefits:		
FICA	342.50	367.09
Workers' Compensation Ins.	186.25	238.13
Liability Insurance	188.00	241.00
Fidelity Bond	104.00	104.00
Supplies:		
Office & Janitorial	100.00	100.00
Lumber	521.67	
Culverts	840.00	250.00
Other	77.77	56.72
Telephone	29.20	
Ditch Rider Travel Exp.	5,000.00	5,000.00
Other Travel Expenses		24.00
Safe Deposit Box Rent	6.00	6.00
Miscellaneous Rents	36.00	42.00
Electricity	792.10	2,510.14
Repair & Maintenance		
Ditches	3,034.80	1,750.00
Pumps	3,776.10	
Weed Spray		368.00
Other	281.94	227.25
Corporation Fee	10.00	10.00
Other Expenses	6.55	29.33
Contract Payments:		
DNRC	10,767.49	10,767.49
FmHA	2,915.00	2,915.00
TOTAL	$34,615.37	$30,867.15

ANNUAL PAYMENT

Payble To	Amount of Annual Payment	Contract Balance
DNRC	$10,767.49	$323,024.56
FmHA	2,915.00*	44,707.15

*Includes interest payment on unpaid balance at 5% per annum.

PETROLIA WATER USERS' ASSOCIATION assessed $6.00 per acre annually last 5 years for operation and maintenance of the project and debt payments to the DNRC and FmHA.

CHAPTER 8

PROJECT EVALUATION

This section of the report presents the economical and financial basis for the improvements of Petrolia Dam. The primary beneficiaries of this storage project are the agricultural water users. Under the Small Reclamation Projects Act Guidelines, agricultural users are required to pay loan proceeds as quickly as they have the "ability to pay". This repayment capacity was estimated by preparing budgets for a representative farm-ranch served by Petrolia Reservoir.

The financial analysis includes only the reimbursable benefits of the project which have been identified as the sale of agricultural water. The economic analysis includes both the reimbursable as well as nonreimbursable benefits. The nonreimbursable benefits have been identified as agricultural consumer surplus, recreation, and flood control. The term "nonreimbursable benefits" refers to those activities that have a social value, but do not have a well defined market value. This is primarily the result of the difficulty of assigning well defined property rights to the various activities.

The economic analysis presents a measure by which the public in general would benefit from the project. The public input would be in the form of nonreimbursable grants from either state or federal origin. Analysis of these nonreimbursable benefits provides justification for the magnitude of the grants needed to finance the project.

AGRICULTURAL PAYMENT CAPACITY

Repayment of loan funds allocated to irrigation for the project under the Small Reclamation Projects Act is dependent on the ability of the irrigators to repay their obligation each year. To determine the irrigator's "ability to pay", a representative farm was determined for the land area irrigated from Petrolia Reservoir. The representative farm was determined by informal surveys with members of the Petrolia Water Users Association, and consultation with the Cooperative Extension Service, Soil Conservation Service, and Agricultural Stabilization and Conservation Service.

The representative farm-ranch is comprised of 500 acres of irrigated land (not all of this is project land) and 3,840 acres of grazing land. The crop mix includes 300 acres of alfalfa hay, 80 acres of feed barley and 100 acres of alfalfa seed. Also included are 20 acres for roads, drains, ditches, and other non-productive land within the irrigated area. The farm-ranch includes a livestock herd of 255 cows.

The basic data on commodity yields and prices was supplied by the Montana Crop and Livestock Reporting Services and the Bureau of Reclamation. All yields are three-year simple average yields for Petroleum County. All prices are twenty-year normalized prices furnished by the Bureau of Reclamation.

The methodology follows procedures adopted by the Bureau of Reclamation and results in a financial summary of the representative farm. For additional details on the calculation of agricultural payment capacity for the Petrolia Water Users Association members, please refer to Appendix E, Farm Budget Analysis worksheets.

Most farm budgets are very sensitive to land prices and returns to operator and family labor, management, and equity. In this study, irrigated land is valued at $600/acre and grazing land is valued at $80/acre. The land price information was obtained from interviews with operators, sales experience, and judgment.

The returns to operator labor and management were estimated from personal interviews. Average annual gross earnings of $14,400 for skilled farm labor was used as a proxy for the return to operator labor. Return to operator management was based on 10% of net farm income. This amount must cover the family living, income and social security taxes, and principal portions of any land debt retirement.

Returns to equity were based on 12-year average statistics reported in Economic Indicators of the Farm Sector, Income and Balance Sheet Statistics (USDA, 1983). The average rate of return was 3.56% over this period, a return which farmers have come to accept. This also agrees quite closely with the 3.6% value recommended by the USBR.

The members of the Petrolia Water Users Association (PWUA) are currently charged $3.00/acre-foot. As shown in Table 8.1, the typical member of the PWUA is estimated to have a repayment capacity of $9.07/acre or $4.54/acre-foot (assuming two acre feet of water is used per acre). The repayment capacity of $4.54/acre-foot is in addition to the current charge of $3.00/acre-foot. Thus, if the Petrolia Dam is rehabilitated, agricultural water sales would be roughly equal to the current price plus the increased repayment capacity, i.e., $7.54/acre-foot.

TABLE 8.1
PAYMENT CAPACITY
PETROLIA WATER USERS ASSOCIATION, PETROLEUM COUNTY, MONTANA
500 ACRE FARM, 3,840 ACRE RANCH

Crop	Acres or Head (A.or Hd.)	Cropping Pattern (%)	Yield or Weight	Units	Unit Price ($)	Total Product (Units)	Farm Use (Units)	Quantity Sold (Units)	Value ($)
CROPS:									
Alfalfa hay	300	63	4.5	Ton	$69.41	1350	600	750	$52,058
Alfalfa seed	100	21	300.0	Lbs.	1.07	30000		30000	$32,100
Barley	80	16	75.0	Bu.	2.60	6000	280	5720	$14,872
Waste	20								
TOTAL CROP SALES									$99,030
LIVESTOCK:									
Cows (cull)	39		10.00	Cwt.	47.87				$18,669
Replacement Heifers	5		9.00	Cwt.	72.21				$3,249
Bulls (cull)	3		15.00	Cwt.	57.85				$2,603
Steer calves	135		5.25	Cwt.	75.81				$53,730
Heifer calves	84		4.75	Cwt.	74.99				$29,921
TOTAL LIVESTOCK SALES									$108,173

Gross farm income	$207,203
Less: Total variable costs	101,122
Return over variable costs	$106,081
Less: Total fixed costs	48,371
Net farm income	$57,710
Less: Return to operator	$14,400
Less: Return to operator management (10% Net farm income)	$5,771
Less:Return to equity	$33,002
Payment capacity	$4,537
Additional payment capacity/acre (500ac)	$9.07
Existing assessment per acre	$6.00
Total payment capacity per acre	$15.07
Payment capacity per AF (2AF/acre)	$7.54

NONREIMBURSABLE BENEFITS

AGRICULTURAL CONSUMER SURPLUS

Consumer surplus refers to the additional value of consuming a commodity that is above the market price. In this case, agricultural consumer surplus refers to the additional value of irrigation water that irrigators receive that is above the market price paid for water.

As previously mentioned, irrigators have the ability to pay a total of $7.54/acre-foot of water in a normal year. However, this does not include the full value of the water to the water user, that is, the consumer surplus. Table 8.2 provides various estimates of the total value of water that the DNRC has used for planning purposes and benefit/cost ratios over the past decade.

TABLE 8.2

ESTIMATED VALUE OF IRRIGATION WATER (HKM February 1985)

Source	Value Per Acre-Foot
Past DNRC Studies	
Snyder	$37
Corrigall	$17.25
Steinbeck	$30-$40
Vinnard	$32
Yellowstone Impact Study	$34
Long	$37
ECO Northwest, Ltd. Study	
Finnie	$34

The average value (about $35/AF) embodies both the market value of the water (i.e., actual water payment) plus the net increase in income (i.e., the residual marginal value product associated

with irrigation water use per AF). In other words, if a farmer/rancher paid $7.54/AF of storage (including OM&R), the consumer surplus would be $27.46/AF assuming water were valued at $35/AF.

The Montana values shown in Table 8.2 are generally similar to the value of water throughout the western United States. Clearly, areas that raise high value crops have higher water values (at least triple); however, the marginal value of western agricultural water (excluding the lower Columbia Basin) averaged approximately $35/AF in 1983 (Frank and Beattie, 1979).

RECREATION BENEFITS

Petrolia Dam currently provides many recreational opportunities in the form of fishing, hunting, boating, water skiing, and camping. Benefits arising from recreational opportunities are measured in terms of willingness to pay by the public (consumer surplus + market value). Most outdoor recreation is publicly provided and there is no direct fee. This makes it difficult to quantify the value of the recreational benefit. There are a variety of methods available to estimate recreation benefits, including the travel cost method, contingent valuation method, and the unit day method. Because of the lack of detailed information necessary for the first two methods, the unit day method is utilized for this study. The procedure generally follows that set forth in the "Principles and Guidelines" used in Federal Water Resource Development (USWRC, 1983).

The entire recreational benefit is claimed for this project simply because the "without project" alternative is to breach the dam. Without the dam there would be no lake-based recreation in this area.

A wide range of values for unit days have been displayed in previous studies. Tables VIII-3-1, VIII-3-2, and VIII-3-3 found in the principles and guidelines were utilized to develop these values (see Appendix F). The values were indexed from July 1982 to January 1986 by use of the Consumer Price Index. The tables are included in Appendix F with selections marked on the tables.

The principles and guidelines make a distinction between "generalized" and "specialized" recreational activities. Two categories are identified as "specialized" in this study based primarily on a unique experience and low density of use for this area. The first category is walleye and northern pike fishing. Petrolia Reservoir has potential as a good warm water fishery. The second category is autumn camping associated with hunting around and below the reservoir. The reservoir provides an excellent base from which to hunt deer and antelope. These uses are unique and the density of use is low. Recreation visitor day statistics are not available for the Petrolia Reservoir. Therefore, alternative data sources were sought. Interviews with persons knowledgeable of recreation activities at the Petrolia Reservoir were used as a basis for the benefit calculations. These persons included the PWUA's caretaker, the region's game warden, the operator of the general store in Winnett, and other local residents. The results of these interviews produced a range of estimates.

The following analysis employs the conservative visitor day estimates from the range produced by the interviews. It is estimated that Petrolia Lake provides fishermen with four months of summer fishing and three months of ice fishing in a normal year. It is further estimated that 40 visitor days of summer fishing and 25 visitor days of ice fishing occur in an average week. This is equivalent to 700 visitor days of summer

fishing and 325 visitor days of ice fishing during an average year. Estimates of boating/water skiing activities indicate that an average of 15 boats per weekend would use the lake during a three-month period. Assuming that each boat carries four people and uses the facility for two days each visit, the boating visitor days total 1,440 per year.

Camping at the Petrolia Reservoir occurs primarily during the three summer months and during one month of the hunting season. There is little or no waterfowl hunting associated with the lake. It is estimated that 30 camps per week, with four persons in each camp, use the facility in the summer; and ten camps per week, with four persons each, are established during the hunting season. This autumn camping of 160 days is considered specialized recreation. Of the 1025 visitor days of fishing, 200 days are estimated to fall into the specialized fishing and hunting category.

Table 8.3 summarizes the total annual value of the recreational benefits of Petrolia Reservoir. The $22,158 value includes the consumer surplus of the recreational activities. Given a 100-year period and a discount rate of 8-5/8%, the present value is $256,842.

FLOOD CONTROL BENEFITS

The value of flood control benefits provided by the Petrolia Dam is estimated as the value of the physical structures that would be damaged by the Probable Maximum Flood (PMF) resulting in a dam breach. It is assumed that the peak flowrate of the PMF occurs at the same time as the breach, resulting in a worst case scenario. HKM Associates provided AMEC, Inc. with a map and reference code for each of the farmsteads that would be affected by such an occurrence. AMEC inspected the properties and estimated their current market value. Table 8.4 summarizes these observations. A brief description of each property follows the table.

TABLE 8.3

ESTIMATE OF ANNUAL RECREATION BENEFITS OF PETROLIA LAKE

Activity	Recreation Visitor Days	User Day Value	Total Value
General Fishing & Hunting			
Summer Fishing	600	$4.73	$2,838
Ice Fishing	225	4.73	1,064
General Recreation			
Boating/Water Skiing	1,440	4.28	6,163
Summer Camping	1,440	4.28	6,163
Specialized Recreation			
Autumn Camping	160	14.91	2,386
Specialized Fishing & Hunting			
Northern Pike/Walleye Fishing	200	17.72	3,544
TOTALS			$22,158

TABLE 8.4

ESTIMATE OF PROPERTY LOSS DUE TO DAM BREACH SUPERIMPOSED UPON PEAK PMF

RMI* Number	Residence Elevation	PMF Elevation	Property Losses	Content Losses	Total Loss
29.7	2,829	2,841	$ 15,000	$ 10,000	$ 25,000
29.5	2,813	2,830	40,000	30,000	70,000
27.8	2,792	2,792	10,000	10,000	20,000
22.2	2,720	2,726	70,000	30,000	100,000
17.6	2,680	2,686	115,000	50,000	165,000
TOTALS			$250,000	$130,000	$380,000

*Source: River Mile Index of the Missouri River, DNRC 1979.

All of the structures located at RMI 29.7 would be destroyed by the PMF. The elevation of the PMF would be 2,841 feet while the residence elevation is 2,829 feet. The farmstead's structures include an old house, old sheds, and two small grain bins. The structure's contents include an automobile, household furnishings, and miscellaneous old machinery.

The water level of the PMF would be 2,830 feet at RMI 29.5, while the main residence has an elevation of 2,813 feet. The elevation of the main residence is higher than the elevation of the other structures. Therefore, all structures and their contents would be destroyed by the PMF. The farmstead consists of three old houses, a one-car garage, two old barns, a small shop, a small grain bin, an old grain elevator, corrals, and other miscellaneous outbuildings.

Most of the structures located at RMI 27.8 are above the 2,792 foot level of the PMF and would not be damaged by the PMF. Two barns, some corrals, a lambing shed, loading chutes, and a steel sided building would be destroyed. In addition, the PMF may introduce a small amount of water in the residence which would damage some of the contents.

The elevation of the foundation of the main residence located at RMI 22.2 is 2,720 feet. The residence's foundation is located at a higher elevation than the foundations of the other structures. All of the structures would be destroyed by the PMF since it would result in a water level which would be six feet above the foundation of the structure with the highest elevation. These structures include a relatively new two-story log home, a trailer house, a garage, lambing sheds, and corrals.

The elevations of the structures at RMI 17.6 are equal to or lower than that of the main residence, which is 2,680 feet. The structures consist of a newer home, a small old home, a trailer house, a large steel building, two large steel quonsets, a loafing shed, small barn, and corrals. All of these structures would be covered by at least six feet of water in the event of the PMF. Therefore, it is assumed that all of the structures and their contents would be destroyed.

It is estimated that structure losses due to the PMF would equal or exceed $250,000. The value of the contents of those structures is estimated to be $130,000. The total property loss due to the PMF is projected to be $380,000. These estimates do not include damage to farmland, infrastructures (roads, bridges, power lines, etc.) or claims from loss of life.

The PMF is expected to be a remote event with probability of recurrence exceeding 1 in 10,000 years. The benefits from protection against this event are relatively small. However, a flood with a recurrence interval of approximately 500 years could result in a dam breach as well. The spillway capacity at the dam crest is approximately 10,500 cfs. Any flow over the crest could result in a breach. It is estimated that an inflow of 22,000 cfs would result in a flow depth of 1 foot over the crest of the dam. This flood was routed down the channel and flood elevations developed at the residences for two cases: without dam, and with a breach of the existing dam. Using information gathered for the PMF study, property losses and content losses were estimated for each of the residences. The large flows resulting from a dam breach are soon attentuated and the lower two residences (RMI 22.2 and 17.6) do not sustain nearly as much damage as they do during a PMF.

Estimates of property loss due to a breach of Petrolia Dam are shown in Table 8.5. The dam breach flows are large compared to the without-dam case. The damage estimates represent the incremental damage that would be attributable to the breach. Property loss would total at least $175,000. This estimate does not include damage to farmland, infrastructure or claims from loss of life. This analysis does not consider losses from other remote events between the 22,000 cfs and PMF floods. This claim of benefits, therefore, should be conservatively low. Since the computed benefit cost ratio was favorable (see following section), a more detailed estimate of flood benefits was not warranted.

Assuming a 100-year period and a discount rate of 8-5/8%, the average annual equivalent benefit is $15,098. It is likely that a more detailed study would increase these benefits.

TABLE 8.5

ESTIMATE OF PROPERTY LOSS DUE TO DAM BREACH

APPROXIMATE 500-YEAR FLOOD DAM BREACH

RMI* Number	Residence Elevation	Flood Elevation	Property Losses	Content Losses	Total Losses
29.7	2,829	2,833	$ 15,000	$ 10,000	$ 25,000
29.5	2,813	2,830	40,000	30,000	70,000
27.8	2,792	2,788	5,000	5,000	10,000
22.2	2,720	2,722	25,000	15,000	40,000
17.6	2,680	2,681	20,000	10,000	30,000
TOTALS			$105,000	$ 70,000	$175,000

*Source: River Mile Index of the Missouri River, DNRC 1979.

COST-BENEFIT ANALYSIS

The total project cost of this rehabilitation is developed in Chapter 7. Benefits, both direct and indirect, accrue from irrigated agriculture, flood control, and recreational benefits. The discount rate used in this analysis is 8-5/8%.

The present value of agricultural water is $3,945,775, based on 9726 AF of water marketed at $35/AF (present value factor of 11.5912). Recreational values show a present value of $256,842. Flood benefits equal a present value of $175,000. Total benefits would equal $4,377,617 divided by $2,707,146 construction costs; the benefit-cost ratio is 1.62.

CHAPTER 9

FINANCIAL PROGRAM

SOURCES OF FUNDING

Financial arrangements are a difficult obstacle to most water resource projects. Several sources of financial assistance were considered including the following:

- Private institutions, including insurance companies, banks, savings and loan institutions, etc.

- State financial assistance through the Water Development Program (bonds backed by coal severance tax revenues).

- Small Reclamation Projects Act (Public Law 84-984) administered by the USDI, Bureau of Reclamation.

- Assistance from other federal agencies such as the Soil Conservation Service and the Farmer's Home Administration.

The recommended financial program is a combination of state financial assistance and the Small Loans Program (Public Law 84-894). This approach has several advantages as follows:

- 40-year term on Public Law 84-984 loan.

- No interest on Public Law 84-984 loan proceeds for agriculture.

- Possible grant for recreational and flood control benefits through Public Law 84-984.

- Technical review of plans and specifications by USBR.

- Flexibility in loan payments as long as "payment capacity" and "loan factor" criteria are met for Public Law 84-984 loan.

- "Applicant's contribution" can be met by Water Development Bureau loan or grant as needed to allow a 50% or less "loan factor".

As developed in the Project Evaluation chapter, the public recreational and flood benefits of Petrolia Reservoir equal a discounted value of $431,842 over a 100-year period. Given the importance of recreation and the public safety concerns, it is suggested that this value or more should be contributed as grant monies by the state and federal agencies toward the total project cost. The funds would originate from at least three sources: 1) a grant under the Small Reclamation Projects Act, 2) a Land and Water Conservation Fund grant administered by the Montana Department of Fish, Wildlife and Parks, and 3) a grant through the DNRC Water Development Fund. It is suggested that the grant(s) be allocated as necessary to keep the "loan factor" below 50% and to allow repayment of the Public Law 84-984 loan within the maximum 40-year period.

ALLOCATION OF PROJECT COSTS

Repayment of loan amounts would be derived by assessments to the Petrolia Water Users Association (PWUA). The PWUA would in turn make the payment to the Montana Department of Natural Resources and Conservation (DNRC). The DNRC would contract for the loan or bond repayment and would secure the loan in the name of the PWUA, through individual water purchase contracts. The PWUA would levy assessments necessary to operate and maintain the dam and to maintain an adequate reserve account.

Assessments would be made at an agricultural rate only. There are no excess lands or municipal and industrial (M&I) uses from this reservoir. Should excess lands or M&I uses develop in the future, these proportionate uses will bear interest at 11-1/8%.

Recreation must be considered in allocation of costs for purposes of a Federal Recreational Grant under the Small Loans Program. Recreation is defined herein as boating, fishing, camping, picnicking, and hiking. Cost allocations are made by use of the Separable Costs-Remaining Benefits method as shown in Table 9.1. This table is simplified from those typically prepared as there are no separable costs associated with this project. For agricultural water the single-purpose alternative cost is $35/AF as developed in Chapter 8, Project Evaluation. As shown in Table 9.2, a grant of one-half of the recreational allocation can be made under the Small Loans Program. The exact allowance amount, by equation, is $156,364 but the grant request is rounded to $150,000.

Historically, some water has been carried over in the reservoir providing recreational benefits. This operation would continue in the future and reservoir levels would remain unchanged. No minimum pool is allocated to this reservoir. It is important to note that total benefits from recreation have been claimed because an unsafe dam would be breached and recreational benefits from this reservoir would be nonexistent. Incremental analysis of recreational benefits is not applicable in a dam safety analysis.

PROJECT REPAYMENT

Projected annual assessments to the water users for the first and last year of repayment are shown in Table 9.3. No additional funds are needed for emergency purposes.

Project interest during construction is nonreimbursable but is calculated in Table 9.4.

The 38-year payout schedule is detailed in Table 9.5.

TABLE 9.1
SEPARABLE COSTS - REMAINING BENEFITS ALLOCATION
8.625 PERCENT INTEREST - 100 YEARS

Item	Irrigation Water Supply, Consumptive Use	Recreation, and Flood Control Use	Total
Costs to be Allocated			
Preconstruction			$239,000
Construction			2,692,146
IDC			116,099
OM&R			197,289
Annual Benefits	($340,410) 1/	($37,256)	377,666
Capitalized Benefits	3,945,775	431,842	4,377,617
Single-Purpose Alternative Costs 2/	3,945,775 2/	2,590,241 3/	6,536,016
Justifiable Expenditure	3,945,775	431,842	4,377,617
Separable Costs			
Preconstruction	0	0	0
Construction	0	0	0
IDC	0	0	0
OM&R	0	0	0
Remaining Justifiable Expenditure	3,945,775	431,842	4,377,617
Percent Distribution	90.14%	9.86%	
Total Allocated Costs			
Preconstruction	215,423	23,577	239,000
Construction	2,426,572	265,574	2,692,146
IDC	104,646	11,453	116,099
OM&R	177,827	19,462	197,289

1/ (9,726 AF x $35/AF)
2/ Least cost alternative is $35/AF - See Chapter 8.
3/ Minimum cost of rehabilitation without breaching.

TABLE 9.2

DETERMINATION OF MAXIMUM ALLOWABLE FEDERAL GRANT

50% of Recreation and Flood Control Construction Costs	$132,787
100% of Recreation and Flood Control Preconstruction Costs	23,577
TOTAL ALLOWABLE	$156,364
AMOUNT REQUESTED	$150,000

TABLE 9.3
ANNUAL ASSESSMENT SCHEDULE ($/AF)

	First Year	28th Year	38th Year
P.L. 984 Loan Repayment	4.38	5.79	4.20
O, M & R	1.75	1.75	1.75
Existing Debt	1.41	0.00	0.00
Emergency Fund	0.00	0.00	0.00
TOTAL	$7.54	$7.54	5.95

TABLE 9.4

PROJECT INTEREST DURING CONSTRUCTION

Discount Rate	8.625%*
Total Project Cost	$2,931,146
Less Preconstruction	$239,000
Less IDC Estimate	$0
	$2,692,146

Year	Distri-bution	Expenditure	One-half of Expenditure	Summation of Prior Years Expenditure	Summation of Prior Years Interest	Amount for Computing Interest	Interest 8.625
FY1	100.0%	$2,692,146	$1,346,073	$0	$0	$1,346,073	$116,099
FY2	0.0%	$0	$0	$0	$0	$0	$0
FY3	0.0%	$0	$0	$0	$0	$0	$0
FY4	0.0%	$0	$0	$0	$0	$0	$0
FY5	0.0%	$0	$0	$0	$0	$0	$0
Totals		$2,692,146					$116.099

* This table is presented as basis for Cost Allocation at 8-5/8% discount rate- actual repayment is at 11-1/8% as shown in Table 7.5

TABLE 9.5
FINANCIAL PROGRAM AND PAYOUT SCHEDULE

H&M Associates
Petrolia Project
September 1986

Total Project Cost	: $2,931,146.27	DNRC 1990 Loan Balance	: $279,954.60	Federal Grants	: $150,000.00
Actual Loan Amount	: $1,765,146.27	FmHA 1990 Loan Balance	: $42,564.58	Payment Capacity / AF	: $7.54
Contracted Water(AF)	: 9726	FmHA Annual Payment (5%)	: $2,915.00	O M & R / AF	: $1.75
Fed. Interest During Const.:	$105,751.26	DNRC Annual Payment (0%)	: $10,767.49	Discount Rate (%)	: 8.625

Year of Repayment (1)	Year (2)	Irrigation Assessment (3)	OM & R Assessment (4)	DNRC Payment (5)	DNRC Balance (6)	FmHA Interest (7)	FmHA Principal (8)	FmHA Balance (9)	Emergency Reserve Annual (10)	Emergency Reserve Accumulation (11)	984 Principal Payment (12)	984 - Loan Balance (13)
1	1990	73303.38	17020.50	10767.49	269187.11	2128.23	786.77	41777.81	0.00	32000.00	42600.39	1722545.88
2	1991	73303.38	17020.50	10767.49	258419.62	2088.89	826.11	40951.70	0.00	32000.00	42600.39	1679945.49
3	1992	73303.38	17020.50	10767.49	247652.13	2047.58	867.42	40084.28	0.00	32000.00	42600.39	1637345.10
4	1993	73303.38	17020.50	10767.49	236884.64	2004.21	910.79	39173.50	0.00	32000.00	42600.39	1594744.72
5	1994	73303.38	17020.50	10767.49	226117.15	1958.67	956.33	38217.17	0.00	32000.00	42600.39	1552144.33
6	1995	73303.38	17020.50	10767.49	215349.66	1910.86	1004.14	37213.03	0.00	32000.00	42600.39	1509543.94
7	1996	73303.38	17020.50	10767.49	204582.17	1860.65	1054.35	36158.68	0.00	32000.00	42600.39	1466943.55
8	1997	73303.38	17020.50	10767.49	193814.68	1807.93	1107.07	35051.62	0.00	32000.00	42600.39	1424343.16
9	1998	73303.38	17020.50	10767.49	183047.19	1752.58	1162.42	33889.20	0.00	32000.00	42600.39	1381742.77
10	1999	73303.38	17020.50	10767.49	172279.70	1694.46	1220.54	32668.66	0.00	32000.00	42600.39	1339142.38
11	2000	73303.38	17020.50	10767.49	161512.21	1633.43	1281.57	31387.09	0.00	32000.00	42600.39	1296541.99
12	2001	73303.38	17020.50	10767.49	150744.72	1569.35	1345.65	30041.45	0.00	32000.00	42600.39	1253941.60
13	2002	73303.38	17020.50	10767.49	139977.23	1502.07	1412.93	28628.52	0.00	32000.00	42600.39	1211341.22
14	2003	73303.38	17020.50	10767.49	129209.74	1431.43	1483.57	27144.94	0.00	32000.00	42600.39	1168740.83
15	2004	73303.38	17020.50	10767.49	118442.25	1357.25	1557.75	25587.19	0.00	32000.00	42600.39	1126140.44
16	2005	73303.38	17020.50	10767.49	107674.76	1279.36	1635.64	23951.55	0.00	32000.00	42600.39	1083540.05
17	2006	73303.38	17020.50	10767.49	96907.27	1197.58	1717.42	22234.13	0.00	32000.00	42600.39	1040939.66
18	2007	73303.38	17020.50	10767.49	86139.78	1111.71	1803.29	20430.84	0.00	32000.00	42600.39	998339.27
19	2008	73303.38	17020.50	10767.49	75372.29	1021.54	1893.46	18537.38	0.00	32000.00	42600.39	955738.88
20	2009	73303.38	17020.50	10767.49	64604.80	926.87	1988.13	16549.25	0.00	32000.00	42600.39	913138.49
21	2010	73303.38	17020.50	10767.49	53837.31	827.46	2087.54	14461.71	0.00	32000.00	42600.39	870538.11
22	2011	73303.38	17020.50	10767.49	43069.82	723.09	2191.91	12269.79	0.00	32000.00	42600.39	827937.72
23	2012	73303.38	17020.50	10767.49	32302.33	613.49	2301.51	9968.28	0.00	32000.00	42600.39	785337.33
24	2013	73303.38	17020.50	10767.49	21534.84	498.41	2416.59	7551.70	0.00	32000.00	42600.39	742736.94
25	2014	73303.38	17020.50	10767.49	10767.35	377.58	2537.42	5014.28	0.00	32000.00	42600.39	700136.55
26	2015	73303.38	17020.50	10767.35	0.00	250.71	2664.29	2350.00	0.00	32000.00	42600.53	657536.02
27	2016	73303.38	17020.50	0.00	0.00	117.50	2350.00	0.00	0.00	32000.00	53815.38	603720.64
28	2017	73303.38	17020.50	0.00	0.00	0.00	0.00	0.00	0.00	32000.00	56282.88	547437.76
29	2018	73303.38	17020.50	0.00	0.00	0.00	0.00	0.00	0.00	32000.00	56282.88	491154.88
30	2019	73303.38	17020.50	0.00	0.00	0.00	0.00	0.00	0.00	32000.00	56282.88	434872.00
31	2020	73303.38	17020.50	0.00	0.00	0.00	0.00	0.00	0.00	32000.00	56282.88	378589.12
32	2021	73303.38	17020.50	0.00	0.00	0.00	0.00	0.00	0.00	32000.00	56282.88	322306.25
33	2022	73303.38	17020.50	0.00	0.00	0.00	0.00	0.00	0.00	32000.00	56282.88	266023.37
34	2023	73303.38	17020.50	0.00	0.00	0.00	0.00	0.00	0.00	32000.00	56282.88	209740.49
35	2024	73303.38	17020.50	0.00	0.00	0.00	0.00	0.00	0.00	32000.00	56282.88	153457.61
36	2025	73303.38	17020.50	0.00	0.00	0.00	0.00	0.00	0.00	32000.00	56282.88	97174.73
37	2026	73303.38	17020.50	0.00	0.00	0.00	0.00	0.00	0.00	32000.00	56282.88	40891.85
38	2027	57912.35	17020.50	0.00	0.00	0.00	0.00	0.00	0.00	32000.00	40891.85	0.00
39	2028	17020.50	17020.50	0.00	0.00	0.00	0.00	0.00	0.00	32000.00	0.00	0.00
40	2029	17020.50	17020.50	0.00	0.00	0.00	0.00	0.00	0.00	32000.00	0.00	0.00
TOTALS		$2,804,178.37	$680,820.00	$279,954.60		$35,692.92	$42,564.58		$0.00		$1,765,146.27	

Present Worth $483,312.10
Loan Factor 0.499

CHAPTER 10

ENVIRONMENTAL ASSESSMENT

ALTERNATIVES INCLUDING THE PROPOSED ACTION

Several alternatives were analyzed in order to develop economical solutions to the problems at Petrolia Reservoir. The following sections discuss the environmental consequences of (1) the proposed action to raise the dam, modify the principal spillway at the existing location, add an auxiliary spillway, and add a fuse plug to allow the dam to adequately pass the PMF; (2) a second alternative to raise the dam, build a principal spillway at a new location with a guard dike, and add an auxiliary spillway to allow the dam to pass the PMF; (3) the option to provide repairs only to the existing principal spillway; (4) the alternative to breach the dam; and (5) the no action alternative. A tabular comparison of the numbered alternatives is presented later in Table 10.1 following more detailed descriptions of the alternatives. None of the alternatives consider raising the normal operating pool of the reservoir.

ALTERNATIVE 1: FUSE PLUG, REPAIR EXISTING PRINCIPAL SPILLWAY, ADD AUXILIARY SPILLWAY - PROPOSED ACTION

Under this plan the dam would have the capacity to pass the PMF without failure of the main dam embankment. This alternative calls for the excavation of a large auxiliary spillway to the right of the existing principal spillway. Excavated material would be placed primarily on the downstream face of the dam embankment, raising the design crest elevation by 3.4 feet. Rehabilitation of the principal spillway would utilize the existing ogee crest while replacing the chute and stilling

basin. This would provide adequate hydraulic capacity for passing the 100-year flood without use of the auxiliary spillway. A fuse plug section of the dam, constructed to the left of the existing principal spillway, would breach during floods greater than the 500-year flood. This plan also provides for erosion protection in the form of adding designated waste areas in Johnson Coulee, seepage control measures, repair or replacement of three of the outlet works gates, and replacement of the first 150 feet of the two canals leaving the dam.

ALTERNATIVE 2: NEW PRINCIPAL SPILLWAY WITH GUARD DIKE, ADD AUXILIARY SPILLWAY

As with the proposed action, spillway capacity would be increased to provide passage of the full PMF without significant damage. This plan provides for the construction of a new, larger principal spillway. The existing principal spillway would be buried. A fuse plug and principal spillway would be installed downstream of a "guard dike" that would act as crest control for the spillway. The fuse plug would be set at an elevation to divert frequent floods to the principal spillway, and fail during the extremely rare events. The fuse plug would be low enough to prevent the release of stored water when failing. An auxiliary spillway would be excavated to the right of the existing principal spillway. Excavated materials would be utilized to raise the dam crest elevation 3.4 feet. Erosion protection in Johnson Coulee, seepage control measures, and repair of the outlet works and canals are other components of this alternative that are identical to Alternative 1.

ALTERNATIVE 3: REPAIR OF PRINCIPAL SPILLWAY

This option would provide for repair of the existing principal spillway so that it could accommodate the 100-year flood without damage. The proposed plan would utilize the existing

ogee crest but replace the chute and stilling basin. A grout cut-off wall would be injected through drilled holes into the foundation materials in front of the spillway to control seepage that has contributed to the undermining of the structure. Erosion protection in Johnson Coulee, seepage control, and repair of the outlet works and canals would also be completed as identified in Alternative 1. The risk of dam failure would remain high.

ALTERNATIVE 4: BREACH EXISTING DAM

Under this alternative the existing dam would be breached and then removed. All materials would be placed in the dry reservoir pool and right abutment areas away from the stream channel. The entire reservoir area would then be reclaimed to native vegetation. Concrete structures would be demolished and buried. Metal components in the outlet works would be salvaged for reuse or scrap.

ALTERNATIVE 5: NO ACTION

Operation of the existing facility would not change. The risk of dam failure would remain high.

ALTERNATIVES THAT WERE ELIMINATED

Other alternatives and options evaluated in the planning process are discussed in Chapter 6 of this report.

ENVIRONMENTAL SETTING

PHYSIOGRAPHY

The watershed area is comprised of a 612-square-mile basin that feeds Petrolia Reservoir. This area can be segregated into four subbasins: 160 square miles of Elk Creek and Yellow Water Creek below Yellow Water Reservoir, 55 square miles of Yellow Water Creek above Yellow Water Reservoir, 97 square miles of Pike Creek and 300 square miles of Flatwillow Creek.

The study watershed is part of the Musselshell River drainage basin that drains into the Missouri River.

Elevations within the watershed area range from approximately 2908 feet NGVD at Petrolia Dam to approximately 8730 feet NGVD along the westerly divide.

An area-altitude analysis was performed on the primary study watershed using 1:250,000 Army Map Service maps to characterize the watershed (USGS, 1954). Mean basin elevation above the dam is 4100 feet NGVD.

Elk Creek, Pike Creek, and Flatwillow Creek drainages assume an elongated shape along the longitudinal axis. The Yellow Water Creek drainage is less elongated. All subdrainages of Flatwillow Creek drain in an easterly direction.

Approximately 25% of the drainage lies in the Snowy Mountains. The terrain in this region is rugged, with moderately high infiltration. The remainder of the basin is characterized by gradually sloping ground surrounded by steep cliffs. Infiltration in this area is also moderately high (MT. Ag. Exp. Sta., 1982 and HKM, 1984).

TABLE 10.1
COMPARISON OF ALTERNATIVES

	Fuse Plug Proposed Action	New Principal Spillway w/Guard Dike	Repair Principal Spillway	Breach Existing Dam	No Action
ALTERNATIVE NUMBER	1	2	3	4	5
Dam					
Height: (ft)	62	62	58.6	0	58.6
Crest Elevation: (ft NGVD)	2,912.0[1/]	2,912.0[1/]	2,908.6	NA	2,908.6[2/]
Reservoir					
Active Storage (AF)					
Permanent Pool	8,380	8,380	8,380	0	8,380
Elevation: (ft NGVD)					
Permanent Pool	2,898.6	2,898.6	2,898.6	NA	2,898.6
100-Year Flood	2,907.6	2,902.2	2,907.6	NA	2,907.6
500-year flood	2,909.5	2,903.6	overtop	NA	overtop
PMF	2,912.0[3/]	2,912.0[3/]	overtop[4/]	NA	overtop [4/]
Acres					
Permanent Pool	510	510	510	0	510
PMF	740	740	overtop	NA	overtop
Principal Spillway					
Existing Spillway	Existing Ogee[5/]	Bury	Existing Ogee[5/]	Remove	Existing Ogee
Chute Width (ft)	97	182	97	NA	100
Spillway Basin Length (ft)	43	36	43	NA	0
Excavation Required (CY)	5,060	16,000	5,060	NA	None
Auxiliary Spillway					
Number	2	1	0	NA	0
Excavation Required (CY)	123,000	33,000	None	None	None
Newly Disturbed Areas (Acres)					
During Construction	25.5	23.1	0	[6/]	0
Permanent	1.2	2.9	0	0	0
Water Supply (AF)	8,380	8,380	8,380	0	8,380
Construction Costs (Millions of $)	2.71	3.23	0.95	1.69	0[7/]

1/ Dike section crest elevation is 2916 feet NGVD.
2/ Design crest elevation. Portions of the crest are as low as 2908.1 feet NGVD.
3/ With freeboard.
4/ Stores and passes 10% of PMF ordinates.
5/ Everything downstream of STA 21+42 is to be removed (original plan stationing).
6/ Dam and reservoir pool area to be revegetated. Embankment materials wasted in the reservoir area.
7/ High potential for flood damages.

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CLIMATE

The regional climate is classified as distinctly continental, and characterized by abundant sunshine, low relative humidity, light rainfall, and wide daily and seasonal variations in temperature. However, the regional climate does not have the extreme variable pattern common to the more mountainous western sections of Montana. In general, the valleys are relatively dry during the colder months and wet during the late spring and early summer. The wettest part of the year in the mountains is generally from midwinter to early spring. Snowfall in the prairie sections of the Petrolia watershed is generally light and does not tend to remain on the ground for long periods of time. It is not uncommon for the region to experience winter warming spells with associated thawing temperatures. Precipitation in the Petrolia watershed ranges from about 13.5 inches at Flatwillow (10 miles southwest of the dam) to amounts in excess of 50 inches in the Big Snowy Mountains. The average annual temperature at Flatwillow is approximately 45°F. Winters are typically cold, with January being the coldest month. The monthly average temperature for January at Flatwillow is about 20°F. July is typically the warmest month of the summer, with an average temperature of about 70°F (COE, 1980).

AFFECTED ENVIRONMENT

WATER RESOURCES

The estimated average annual natural inflow to Petrolia Reservoir for the study period of 1922-1950 is 44,700 acre-feet (HKM, June 1985). After allowance for upstream uses, the average annual actual inflow is estimated to be 24,900 acre-feet.

Storage releases typically occur from May through August.

The existing principal spillway crest is at 2898.6 feet NGVD with a reservoir surface area of 510 acres and a total storage capacity of 8380 acre-feet (Streamworks, 1985).

Under current conditions, a PMF event would exceed the capacity of the existing principal spillway, resulting not only in the loss of the spillway but of the dam itself.

The major stream pollutant of the subbasin is suspended sediment. Mean annual sediment yields for the drainage basin above Petrolia Reservoir average 85 tons per square mile per year (Streamworks, 1985). The bulk of this sediment is carried during the spring months.

Water quality data for two sampling sites in the subbasin are shown in Table 10.2. Sampling site locations are shown in Figure 10.1.

Flatwillow Creek above Petrolia Reservoir is a calcium-bicarbonate type water. Yellow Water Creek is a saline stream with high dissolved solids and extreme hardness. Fecal coliform concentrations for Yellow Water Creek exceeded state water quality standards.

SOILS

Mean annual sediment yields for the drainage basin above Petrolia Reservoir average 85 tons/square mile/year. This has resulted in the loss of storage space at an average rate of 33 acre-feet/year. Over the past 33 years accumulated sediment has displaced 1110 acre-feet of storage space, accounting for a 12% loss of capacity. The largest accumulation of sediment occupies the Flatwillow Creek area of the reservoir. Sediment delivery to the reservoir occurs mainly during major runoff periods. The erosive nature of the soils in the area along with heavy grazing and poor land use practices contribute to sediment accumulation in the reservoir (Streamworks, 1985).

TABLE 10.2

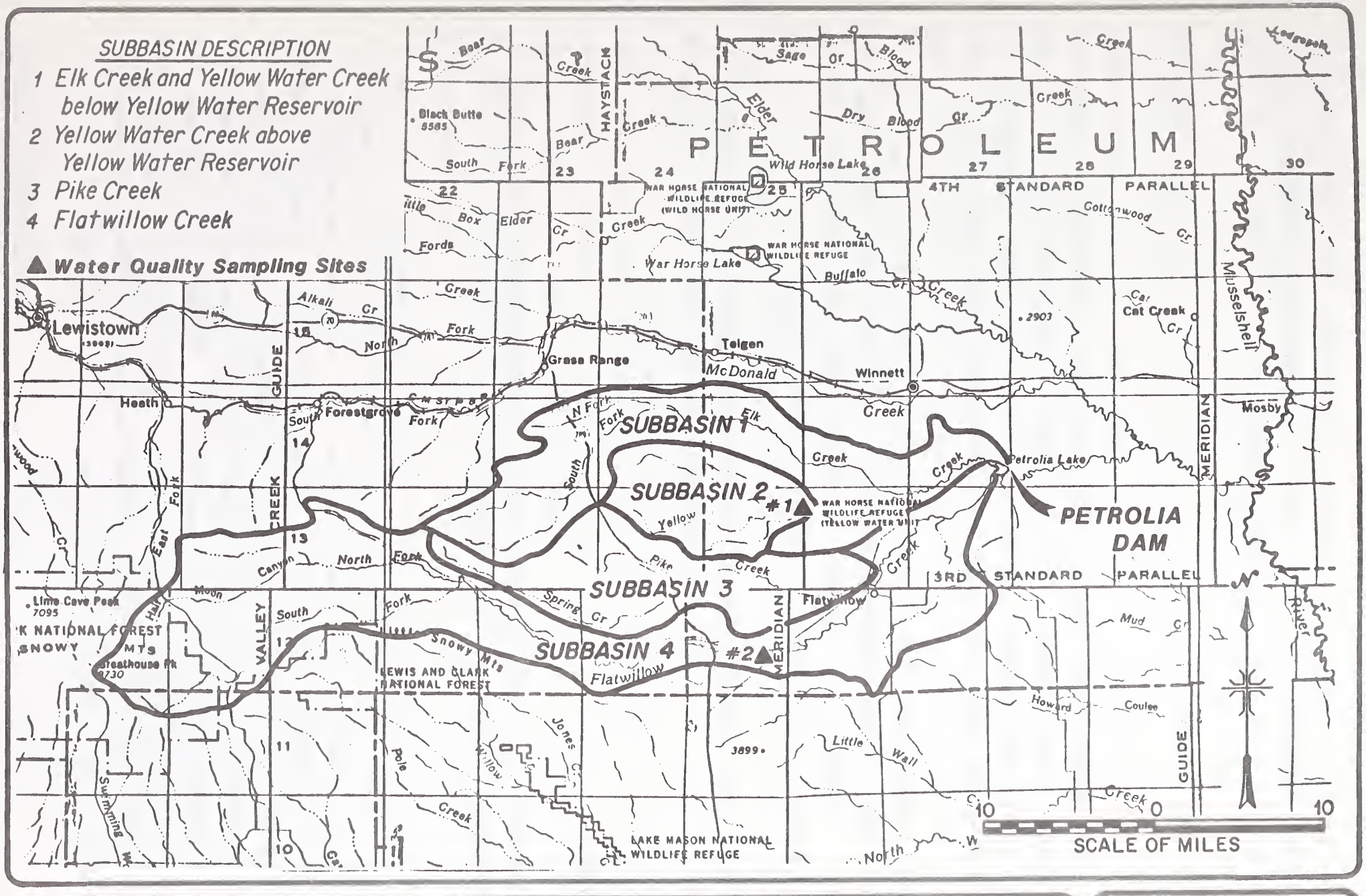
WATER QUALITY SAMPLING SITES

Sampling Site	Date	Temp. °F	Field pH	Turbidity JTU	Specific Conductance micromhos	Total Alkalinity	Total Hardness	Total Suspended Solids	SAR	NO_3	PO4	Fecal Coliform No./100 ml
Yellow Water Creek	7/1/74	78.4	8.4	36	7850	294	2890	63	10.5	1.3	0.19	1800
(13N 26E 06)	8/8/74	64.4	8.2	32	8820	464	3405	22	20.1	0.25	1.1	1/
Flatwillow Creek	7/1/74	68.9	7.3	20	768	210	367	23	0.3	1.2	0.04	50
(12N 25E 24)	8/8/74	63.3	8.0	14	1118	223	375	6	0.5	3.5	0.03	33
	2/12/75	33.8	--	51	1437	293	784	--	0.5	0.49	0.12	--

1/ Too numerous to count.

All results in mg/l unless otherwise designated.

Reference: Montana Water Quality Bureau



PETROLIA DAM REHABILITATION STUDY

WATER QUALITY SAMPLING SITES

FIGURE 10.1

HKM ASSOCIATES
ENGINEERS · PLANNERS

3M087.118 | JUNE 1986

The area in the vicinity of Petrolia Reservoir is comprised of three major land forms: the alluvial bottom lands, two levels of alluvial terraces, and the shale uplands.

Soils of the bottom lands are heavy-textured, with high water tables.

Soils associated with the low alluvial terraces have textures which range from loams to clay loams. Depth to gravel is usually 24 to 36 inches. Soil textures are heavy enough to provide adequate water holding capacities for good crop yields.

Depth to gravel on the higher alluvial terraces is about 24 inches. They have somewhat steeper slopes than the lower terraces. These soils are more suited to sprinkler irrigation, due to slope and the somewhat dissected topography.

Soils of the shale upland areas are shallow with heavy textures. Depth to shale averages 20 to 30 inches. High salinity and sodicity make these soils nonarable.

VEGETATION

Two distinct types of vegetative cover are associated with the area surrounding Petrolia Reservoir.

Native grasses comprise the largest percentage of the vegetation found on the alluvial terraces and shale uplands. Major grass species in these areas are western wheatgrass, bluebunch wheatgrass, green needlegrass, blue gramma, and needle-and-thread. Areas subjected to heavy grazing pressure exhibit increased amounts of blue gramma, needle-and-thread, prairie junegrass, and big sagebrush. Forbs and shrubs, including prickley pear, yucca, and big sagebrush generally comprise less than 15 percent of the vegetative cover in these areas (SCS, 1981). There are no trees in the vicinity.

Areas along the creek bottoms and drainage areas are characterized by increased numbers of trees and shrubs. Typical species include wild rose, chokecherry, buffaloberry, willows, cottonwood, and big sagebrush.

WILDLIFE

The project area is considered to be a very productive wildlife habitat. Vegetation provides good cover and forage for both whitetail and mule deer. Whitetail deer are generally confined to areas along the creek bottoms. Good fawn production occurs during the peak fawning periods of April and early May. Mule deer are found in both the riparian and upland areas. The uplands are also heavily populated with antelope. Other mammalian species common to the area include bobcat, cottontail rabbit, raccoon, fox, skunk, coyote, and various rodents.

Bird species associated with riparian and upland areas include the pheasant, hawk, owl, sage grouse, meadowlark, horned lark, killdeer, robin, and redwing blackbird.

Upstream wetland areas above the reservoir are an important migratory stopover for several species of waterfowl. Canada geese nest in these areas. Other waterfowl observed in the area include the snow goose, blue heron, pelican, and seagull. Several hundred mallard ducks winter in a hotsprings area along Box Elder Creek.

FISH

Water shortages in the basin have made it difficult to maintain a sport fishery in the reservoir. The reservoir was completely drained in 1979 for maintenance and repair work. At that time the fishery population consisted largely of carp and suckers along with a few walleye and ling. The reservoir was subsequently stocked with rainbow trout over a 3- to 4-year

period. Currently, the Montana Department of Fish, Wildlife and Parks (MDFWP) is attempting to establish a "warm-cool" fishery consisting of northern pike and walleye. Plans provide for the yearly stocking of fry or small fish.

Presently there is no spawning of game fish in the reservoir. Walleye could spawn and maintain a population in the reservoir if water levels were adequate.

When flows are sufficient the fishery downstream of Petrolia Reservoir consists primarily of carp that have been flushed from the reservoir.

THREATENED AND ENDANGERED SPECIES

Threatened or endangered species are not known to inhabit the area, although bald eagles do migrate through the region. There is a remote possibility that Peregrine falcons may be present, however, no sightings have been made (MDFWP, 1985).

RECREATIONAL ACTIVITIES

Recreation in the area includes hunting, summer and ice fishing, boating, water skiing, and camping. A small picnic area/campground is located along the northern shore of the reservoir. An A-frame cabin is located along the shore of the reservoir in the SESWNW1/4 of Section 36, Township 14N, and Range 27E. A detailed analysis of recreational activities can be found in Chapter 8 of this report.

LAND USE

Land use in the region can be divided into two principal categories. Federal non-cropland accounts for 34% of land while state and private agricultural lands comprise about 65% of land in Petroleum County. Approximately 89% of the

agricultural land is classified as rangeland, with 5% dryland and irrigated cropland, 2% pasture, and 3% forest (USBR, 1972).

Project lands including the area occupied by the reservoir total 742 acres. Of these, 578 acres are state-owned, with the remaining 164 acres consisting of an easement on privately held lands.

Irrigated lands served by Petrolia Reservoir account for approximately 4890 acres.

Wildlife habitat and recreational activities are other uses of land in the area.

AIR QUALITY

Air quality in the area is good. There are no industrial sources of air contaminants. Wind blown dust, spores, and pollen are seasonal additions to suspended particulate matter. Other air contaminates include herbicides and pesticides from spraying.

ESTHETICS

The upland areas surrounding the reservoir present a "big plains" landscape having average scenic quality. Strong linear contrasts are provided by riparian areas along the creek bottoms. Petrolia Reservoir and the creeks in the area enhance local scenic values.

CULTURAL RESOURCES

A cultural resource file search conducted by the State Historic Preservation Office (SHPO) failed to identify any currently recorded sites in the immediate vicinity of Petrolia Dam and

Reservoir. SHPO recommended that an intensive cultural resource survey be conducted for any impacted areas.

During October of 1985, Anthro Research, Inc. conducted a surface reconnaissance cultural resources survey of a 600-acre area surrounding Petrolia Dam and Reservoir. Prehistoric and historic sites were identified. Additional testing is recommended for all sites in order to establish National Register of Historic Places eligiblity. Impacts to National Register eligible sites will be considered in compliance with Section 106 of the National Historic Preservation Act and its implementing regulations 36CFR800; and the Montana Antiquities Act, when applicable.

SOCIO-ECONOMIC

Petroleum County is one of the more sparsely populated counties in Eastern Montana. The population is 100% rural and includes less than 2000 people. The population density is less than one person per square mile (USBR, 1972).

The operation of Petrolia Reservoir provides beneficial uses in terms of agricultural water supply, recreational benefits, flood control, and fish/wildlife habitat.

Agricultural water supplied by Petrolia Reservoir has a present value of $3,945,775 (present value factor of 11.5912; 100 years at 8-5/8%, 9726/AF marketed). This is assuming a $35 per acre-foot value which includes both the market value of the water plus the net increase in income to the user associated with the crop grown with the irrigation water.

The present value of recreational benefits derived from the reservoir are estimated at $256,842.

Flood control benefits, estimated as the present value of the physical structures that would be damaged by a breach of the dam during the approximate 500-year flood total $175,000.

A detailed analysis of economic benefits is presented in Chapter 8 of this report.

Presently, Petrolia Dam does not meet current safety standards. The risk of dam failure and liability to the State of Montana is high.

ENVIRONMENTAL CONSEQUENCES

ALTERNATIVE 1: FUSE PLUG, REPAIR EXISTING PRINCIPAL SPILLWAY, ADD AUXILIARY SPILLWAY - PROPOSED ACTION.

The impacts of the proposed action on each category of the affected environment are described in the following sections.

Water Resources

This plan provides for the passage of the full PMF. The right auxiliary spillway is designed to operate during floods in excess of the 100-year flood. A fuse plug in the left auxiliary spillway would wash out for floods exceeding the 500-year flood. Significant flooding would occur after failure of the second auxiliary spillway fuse plug.

There would be no increase in normal reservoir level or storage. Reservoir releases would remain unchanged.

No significant change in water quality would be expected.

Soils

The area of cut required for the addition of the right auxiliary spillway and repair of the existing principal spillway consists of approximately 13.9 Ac. A 1.2-acre tract

would be utilized as a borrow area. Topsoil would be stripped and stockpiled for later use in reclaiming the disturbed areas. Excess or unsuitable earth materials would be wasted in designated areas in Johnson Coulee.

Vegetation

Vegetation consisting of native grasses would be disturbed on 25.5 acres, then reestablished on all but 1.2 acres that would be riprapped.

Wildlife

Construction activity during certain times of the year may temporarily disrupt seasonal waterfowl nesting and migration as well as fawn production in the vicinity of the reservoir. The periods of concern include the months of April, May, and early November.

Fish

It is anticipated that construction on the dam would require drawdown of the pool. The effects of the drawdown would be of the same severity as that of a heavy irrigation drawdown. Coordination with the MDFWP would be required to minimize the impacts to the fishery.

Threatened and Endangered Species

There are no known threatened or endangered species in the area.

Recreation

An A-frame cabin would be relocated to allow for construction of the right auxiliary spillway. Recreational activities would not be affected by this action.

Land Use

Additional land that would be occupied by the dam and new right auxiliary spillway totals 15.4 acres.

Esthetics

No significant changes to visual quality of the reservoir area would occur.

Cultural Resources

With this plan, the potential maximum reservoir levels during the PMF would increase. This extremely rare increase of water levels would result in additional inundation of several sites.

Air Quality

Air quality would be slightly affected only during construction by dust and exhaust from heavy equipment.

Socio-Economic

Minimal impacts would occur during construction due to the temporary influx of construction personnel into the area. The primary impact would be a short-term increase in expenditures by construction workers.

Benefits would be derived from the increased safety of the dam structure and a reduction in potential flood damages.

In the event of a fuse plug failure of the second auxiliary spillway, minor flood damage may occur to a few farms downstream of the reservoir.

ALTERNATIVE 2: NEW PRINCIPAL SPILLWAY WITH GUARD DIKE, ADD AUXILIARY SPILLWAY

This alternative would provide for a 3.4-foot increase in the height of the dam, the construction of a new guard dike and principal spillway and the addition of an auxiliary spillway. The existing principal spillway would be buried.

The following sections discuss impacts resulting from this action that differ from those previously described for the proposed action.

Water Resources

Under this arrangement, water would spill over a guard dike and funnel into the new principal spillway. Floods that approach the capacity of the principal spillway would breach the fuse plug adjoining the principal spillway. The guard dike and auxiliary spillway would provide for passage of the full PMF. Downstream flooding as a result of failure of the fuse plug would be negligible.

Soils

Two separate cut areas required for construction of the new principal spillway and auxiliary spillway would consist of 5.6 acres and 3.2 acres respectively.

Vegetation

Native grasses would be removed on a total of 23.1 acres. All but 2.9 acres consisting of the fuse plug and areas to be riprapped would be revegetated.

Recreation

The A-frame cabin in the SE 1/4 SW 1/4 NW 1/4 of Sec. 36 T.14N. R.27E. would not be disturbed under this plan.

Land Use

Additional land to be occupied by the new principal spillway, right auxiliary spillway, and dam would total 15.3 acres.

ALTERNATIVE 3: REPAIR OF PRINCIPAL SPILLWAY

This alternative does not call for modifications to the dam but would require repairs and improvements to the existing principal spillway. The following sections discuss impacts resulting from this action that differ from those previously described for the proposed action.

Water Resources

Repairs to the principal spillway would eliminate the immediate risk of flood damage to the structure for floods less than or equal to the 100-year flood. Freeboard would be minimal (one foot) during the 100-year flood, leaving a great risk of overtopping failure from waves.

Soils

No new areas would be disturbed and therefore, no impact on soils is anticipated. However, in the event of a large flood, dam failure would result in considerable damage to soils downstream of the reservoir.

Cultural Resources

No impacts would result. Maximum reservoir levels would not increase during flood events.

Socio-Economic

With this plan there would be a relatively high risk of dam failure and large flood damages downstream of the reservoir.

ALTERNATIVE 4: BREACH EXISTING DAM

This plan calls for the breach and removal of the dam, followed by reclamation of the reservoir area.

Water Resources

The outflow at the existing dam site would revert to unregulated flow conditions. The current water supply of 8380 AF provided by the reservoir would be eliminated.

Soils

Impacts to soils would occur due to increased sedimentation resulting from erosion of the exposed reservoir area. This would decrease as the area stabilized and revegetated.

Vegetation

No impacts to vegetation would occur. The reservoir area would be revegetated to native species.

Wildlife

This action would result in the loss of valuable waterfowl nesting habitat upstream of the dam.

Fish

The fishery resources of the reservoir would revert to a stream ecosystem.

Recreation

The recreational value of the area would be reduced. Boating and fishing activity would be eliminated.

Land Use

Recreational use of the area would decrease. There would be a severe reduction of irrigated cropland downstream of the reservoir.

Esthetics

Once revegetated, the scenic quality of the area would return to its pre-project state. The loss of the reservoir would diminish local scenic values.

Cultural Resources

Dewatering of the reservoir would expose those portions of the cultural resource sites now inundated by the reservoir.

Socio-Economic

State liability for potential flood damages would be eliminated. The economics of the area would be adversely impacted by the loss of irrigated agriculture.

ALTERNATIVE 5: NO ACTION ALTERNATIVE

There would be no immediate impacts to the environment resulting from this action. However, there is a potential for adverse effects owing to the possibility of dam failure. Potential impacts are described in the following sections.

Water Resources

Assuming that the dam is regraded to 2908.6 feet NGVD, the existing facility will pass the 100-year flood with 1' of freeboard and significant risk of structural damage to the spillway.

Socio-Economic

Potential liability to the State of Montana and the Petrolia Water Users is high. A large flood would result in the loss of the dam and significant damage downstream of the reservoir. The current users would be burdened with the expense of rebuilding the dam.

MITIGATION OF ENVIRONMENTAL CONSEQUENCES

Specific mitigation measures for potential environmental impacts resulting from the rehabilitation of Petrolia Reservoir are outlined below.

SOILS

- Topsoil removed from cut areas would be stockpiled for use in reclamation of these areas following construction.
- Unused earth materials would be wasted and contoured in designated areas.
- Construction activities would be managed to minimize erosion.

VEGETATION

- Except for structure sites, fuse plugs, and areas to be riprapped, all disturbed areas would be revegetated with native grass species.

WILDLIFE

- Construction activities would be limited because of normal reservoir operations during crucial seasons. Impacts to fawn production and waterfowl nesting would be minimal.

FISH

- The MDFWP would be contacted to mitigate impacts from anticipated reservoir drawdowns during construction.

CULTURAL RESOURCES

- Limited testing of all affected sites would be conducted by a qualified archaeologist. An evaluation would be made of the significance of any remaining cultural materials. Impacts to significant cultural resources would be considered in compliance with Section 106 of the National Historic Preservation Act and its implementing regulations 36CFR800.

AIR QUALITY

- Construction plan would include dust abatement requirements.

CONCLUSIONS

Because normal reservoir operations would not change as a result of dam rehabilitation, no significant environmental impacts would occur. It is recommended that a "Finding of No Significant Impact (FONSI)" be prepared in compliance with the National Environmental Policy Act.

A cultural resource inventory of the reservoir area has identified existing impacts to potentially significant cultural resource sites resulting from historic reservoir operations. These impacts would increase after rehabilitation only during rare flood events.

A budget has been prepared for additional cultural resource work including subsurface testing and accurate surface mapping to determine which of the impacted sites are elgible for the National Register of Historic Places. Once sites eligible for listing with the National Register have been identified, the nature and extent of potential impacts to these sites will be evaluated followed by recommendations for mitigation.

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APPENDICES

APPENDIX A

YELLOW WATER CREEK BASIN MODEL

Petrolia: Yellow Water Basin Model: Normal Storage = 4500 , Dead Storage = 50

(A) Date	(B) Petrolia Natural Inflow	(C) Yellow Water Above YW	(D) NIR Above Petrolia Ft	(E) Irrigation Eff(%)	(F) Pre 1935 Acres Above YW	(G) Pre 1935 Desired Diversion	(H) Pre 1935 Actual Diversion	(I) Return Flow	(J) Stream Flow (AF)	(K) Pre 1950 Acres Above YW	(L) Pre 1950 Desired Diversion	(M) Available Flow After YW Rights	(N) Pre 1950 Actual Diversion	(O) Return Flow	(P) YW Reservoir Inflow	(Q) YW 1935 Acres Below YW	(R) YW 1935 Desired Diversion	(S) YW 1935 Actual Diversion	(T) Return Flow	(U) YW Res Spilled Flow	(V) YW Res EOM Storage	(W) YW Cr Entering Petrolia	FW Cr Above Petrolia
Jan-22	1140	334							334						334					334	4500	334	806
Feb-22	791	232							232						232					232	4500	232	560
Mar-22	8455	2474							2474						2474					2474	4500	2474	5981
Apr-22	4760	1393		0.28					1393						1393					1393	4500	1393	3367
May-22	11478	3359	0.195	0.28	359	250	250	78	3187	205	143	2173	143	44	3088	1455	1013	1013	314	2075	4500	2389	8119
Jun-22	23223	6796	0.291	0.28	359	373	373	170	6593	205	213	5112	213	97	6477	1455	1512	1512	689	4965	4500	5653	16427
Jul-22	11575	3388	0.515	0.28	359	660	660	309	3036	205	377	419	377	176	2835	1455	2676	2676	1252	159	4500	1411	8188
Aug-22	1717	502	0.409	0.50	359	294	294	237	445	205	168	-643	0	102	547	1455	1190	1190	959	0	3857	959	1214
Sep-22	0	0	0.171	0.50	359	123	0	103	103	205	70	-1003	0	35	138	1455	498	498	515	0	3497	515	0
Oct-22	0	0		0.50				18	18					0	18				141	0	3515	141	0
Nov-22	656	250						0	250					0	250				30	0	3765	30	605
Dec-22	1169	342							342						342					0	4107	0	827
Jan-23	1330	389							389						389					0	4496	0	941
Feb-23	950	278							278						278					274	4500	274	672
Mar-23	1710	500							500						500					500	4500	500	1210
Apr-23	3002	879		0.28					879						879					879	4500	879	2123
May-23	7479	2189	0.195	0.28	359	250	250	78	2016	205	143	1003	143	44	1918	1455	1013	1013	314	904	4500	1218	5290
Jun-23	32913	9632	0.291	0.28	359	373	373	170	9429	205	213	7947	213	97	9313	1455	1512	1512	689	7800	4500	8489	23281
Jul-23	39762	11636	0.515	0.28	359	660	660	309	11285	205	377	8668	377	176	11084	1455	2676	2676	1252	8408	4500	9660	28126
Aug-23	8972	2626	0.409	0.50	359	294	294	237	2569	205	168	1480	168	135	2536	1455	1190	1190	959	1346	4500	2305	6346
Sep-23	3631	1063	0.171	0.50	359	123	123	127	1067	205	70	628	70	73	1069	1455	498	498	515	572	4500	1087	2568
Oct-23	4118	1205		0.50				35	1240					20	1260				141	1260	4500	1401	2913
Nov-23	3725	1090						7	1097					4	1102				30	1102	4500	1131	2635
Dec-23	2945	862							862						862					862	4500	862	2083
Jan-24	2375	695							695						695					695	4500	695	1680
Feb-24	1900	556							556						556					556	4500	556	1344
Mar-24	3506	1026							1026						1026					1026	4500	1026	2480
Apr-24	11495	3364		0.28					3364						3364					3364	4500	3364	8131
May-24	16941	4958	0.195	0.28	359	250	250	78	4785	205	143	3772	143	44	4687	1455	1013	1013	314	3673	4500	3987	11983
Jun-24	18758	5489	0.291	0.28	359	373	373	170	5286	205	213	3805	213	97	5170	1455	1512	1512	689	3658	4500	4347	13269
Jul-24	14834	4341	0.515	0.28	359	660	660	309	3990	205	377	1373	377	176	3789	1455	2676	2676	1252	1113	4500	2365	10493
Aug-24	3272	958	0.409	0.50	359	294	294	237	901	205	168	-188	0	102	1002	1455	1190	1190	959	0	4312	959	2314

Petrolia: Yellow Water Basin Model: Normal Storage = 4500 , Dead Storage = 50 :

(A) Date	(B) Petrolia Natural Inflow	(C) Yellow Water Above YW	(D) NIR Above Petrolia Ft	(E) Irrigation Eff(%)	(F) Pre 1935 Acres Above YW	(G) Pre 1935 Desired Diversion	(H) Pre 1935 Actual Diversion	(I) Return Flow	(J) Stream Flow (AF)	(K) Pre 1950 Acres Above YW	(L) Pre 1950 Desired Diversion	(M) Available Flow After YW Rights	(N) Pre 1950 Actual Diversion	(O) Return Flow	(P) YW Reservoir Inflow	(Q) YW 1935 Acres Below YW	(R) YW 1935 Desired Diversion	(S) YW 1935 Actual Diversion	(T) Return Flow	(U) YW Res Spilled Flow	(V) YW Res EOM Storage	(W) YW Cr Entering Petrolia	FW Cr Above Petrolia
Sep-24	737	216	0.171	0.50	359	123	123	127	220	205	70	-430	0	35	255	1455	498	498	515	0	4070	515	522
Oct-24	441	129		0.50				35	164					0	164				141	0	4233	141	312
Nov-24	1445	423						7	430					0	430				30	164	4500	194	1022
Dec-24	1748	512							512						512					512	4500	512	1236
Jan-25	1463	428							428						428					428	4500	428	1035
Feb-25	1710	500							500						500					500	4500	500	1210
Mar-25	4674	1368							1368						1368					1368	4500	1368	3306
Apr-25	3325	973		0.28					973						973					973	4500	973	2352
May-25	6111	1788	0.195	0.28	359	250	250	78	1616	205	143	603	143	44	1517	1455	1013	1013	314	504	4500	818	4323
Jun-25	7776	2276	0.291	0.28	359	373	373	170	2072	205	213	591	213	97	1956	1455	1512	1512	689	444	4500	1133	5500
Jul-25	10012	2930	0.515	0.28	359	660	660	309	2579	205	377	-38	0	60	2638	1455	2676	2676	1252	0	4462	1252	7082
Aug-25	1610	471	0.409	0.50	359	294	294	237	414	205	168	-794	0	20	434	1455	1190	1190	959	0	3706	959	1139
Sep-25	0	0	0.171	0.50	359	123	0	103	103	205	70	-1189	0	0	103	1455	498	498	515	0	3311	515	0
Oct-25	0	0		0.50				18	18					0	18				141	0	3328	141	0
Nov-25	645	189						0	189					0	189				30	0	3517	30	456
Dec-25	751	220							220						220					0	3737	0	531
Jan-26	467	137							137						137					0	3873	0	331
Feb-26	422	123							123						123					0	3997	0	298
Mar-26	467	137							137						137					0	4134	0	331
Apr-26	627	183		0.28					183						183					0	4317	0	444
May-26	4907	1436	0.195	0.28	359	250	250	78	1264	205	143	67	98	30	1196	1455	1013	1013	314	0	4500	314	3471
Jun-26	5743	1681	0.291	0.28	359	373	373	170	1477	205	213	-13	0	21	1499	1455	1512	1512	689	0	4487	689	4062
Jul-26	10035	2937	0.515	0.28	359	660	660	309	2585	205	377	-95	0	9	2594	1455	2676	2676	1252	0	4405	1252	7098
Aug-26	1610	471	0.409	0.50	359	294	294	237	414	205	168	-871	0	0	414	1455	1190	1190	959	0	3629	959	1139
Sep-26	0	0	0.171	0.50	359	123	0	103	103	205	70	-1267	0	0	103	1455	498	498	515	0	3233	515	0
Oct-26	831	243		0.50				18	261					0	261				141	0	3494	141	568
Nov-26	0	0						0	0					0	0				30	0	3494	30	0
Dec-26	409	120							120						120					0	3614	0	269
Jan-27	285	83							83						83					0	3697	0	202
Feb-27	257	75							75						75					0	3772	0	181
Mar-27	4750	1390							1390						1390					662	4500	662	3360
Apr-27	2052	601		0.28					601						601					601	4500	601	1451

Petrolia: Yellow Water Basin Model: Normal Storage = 4500 , Dead Storage = 50

(A) Date	(B) Petrolia Natural Inflow	(C) Yellow Water Above YW	(D) NIR Above Petrolia Ft	(E) Irrigation Eff(%)	(F) Pre 1935 Acres Above YW	(G) Pre 1935 Desired Diversion	(H) Pre 1935 Actual Diversion	(I) Return Flow	(J) Stream Flow (AF)	(K) Pre 1950 Acres Above YW	(L) Pre 1950 Desired Diversion	(M) Available Flow After YW Rights	(N) Pre 1950 Actual Diversion	(O) Return Flow	(P) YW Reservoir Inflow	(Q) YW 1935 Acres Below YW	(R) YW 1935 Desired Diversion	(S) YW 1935 Actual Diversion	(T) Return Flow	(U) YW Res Spilled Flow	(V) YW Res EOM Storage	(W) YW Cr Entering Petrolia	FW Cr Above Petrolia
May-27	31001	9072	0.195	0.28	359	250	250	78	8900	205	143	7886	143	44	8801	1455	1013	1013	314	7788	4500	8102	21929
Jun-27	29303	8575	0.291	0.28	359	373	373	170	8372	205	213	6891	213	97	8256	1455	1512	1512	689	6744	4500	7433	20728
Jul-27	14511	4247	0.515	0.28	359	660	660	309	3895	205	377	1279	377	176	3695	1455	2676	2676	1252	1018	4500	2270	10264
Aug-27	2721	796	0.409	0.50	359	294	294	237	739	205	168	-349	0	102	841	1455	1190	1190	959	0	4151	959	1925
Sep-27	1209	354	0.171	0.50	359	123	123	127	358	205	70	-454	0	35	393	1455	498	498	515	0	4046	515	855
Oct-27	973	285		0.50				35	320					0	320				141	0	4366	141	688
Nov-27	2072	606						7	614					0	614				30	479	4500	509	1465
Dec-27	1995	584							584						584					584	4500	584	1411
Jan-28	1710	500							500						500					500	4500	500	1210
Feb-28	1425	417							417						417					417	4500	417	1008
Mar-28	3040	890							890						890					890	4500	890	2150
Apr-28	3211	940		0.28					940						940					940	4500	940	2271
May-28	6975	2041	0.195	0.28	359	250	250	78	1869	205	143	856	143	44	1770	1455	1013	1013	314	757	4500	1071	4934
Jun-28	5998	1755	0.291	0.28	359	373	373	170	1552	205	213	71	103	63	1512	1455	1512	1512	689	0	4500	689	4242
Jul-28	12791	3743	0.515	0.28	359	660	660	309	3392	205	377	751	377	152	3167	1455	2676	2676	1252	491	4500	1743	9048
Aug-28	1835	537	0.409	0.50	359	294	294	237	480	205	168	-619	0	91	571	1455	1190	1190	959	0	3881	959	1298
Sep-28	122	36	0.171	0.50	359	123	36	110	110	205	70	-972	0	35	145	1455	498	498	515	0	3528	515	86
Oct-28	0	0		0.50				23	23					0	23				141	0	3551	141	0
Nov-28	485	142						2	144					0	144				30	0	3695	30	343
Dec-28	665	195							195						195					0	3890	0	470
Jan-29	584	171							171						171					0	4061	0	413
Feb-29	527	154							154						154					0	4215	0	373
Mar-29	6650	1946							1946						1946					1661	4500	1661	4704
Apr-29	2062	603		0.28					603						603					603	4500	603	1458
May-29	8466	2483	0.195	0.28	359	250	250	78	2311	205	143	1298	143	44	2212	1455	1013	1013	314	1199	4500	1513	6003
Jun-29	10578	3096	0.291	0.28	359	373	373	170	2893	205	213	1411	213	97	2777	1455	1512	1512	689	1264	4500	1953	7483
Jul-29	10459	3061	0.515	0.28	359	660	660	309	2709	205	377	93	134	101	2676	1455	2676	2676	1252	0	4500	1252	7398
Aug-29	1610	471	0.409	0.50	359	294	294	237	414	205	168	-727	0	49	463	1455	1190	1190	959	0	3773	959	1139
Sep-29	0	0	0.171	0.50	359	123	0	103	103	205	70	-1110	0	13	115	1455	498	498	515	0	3390	515	0
Oct-29	0	0		0.50				18	18					0	18				141	0	3408	141	0
Nov-29	255	75						0	75					0	75				30	0	3483	30	181
Dec-29	538	158							158						158					0	3640	0	381

Petrolia: Yellow Water Basin Model: Normal Storage = 4500 , Dead Storage = 50 :

(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)	(U)	(V)	(W)	
Date	Petrolia Natural Inflow	Yellow Water Above YW	NIR Above Petrolia Ft	Irrigation Eff(%)	Pre 1935 Acres Above YW	Pre 1935 Desired Diversion	Pre 1935 Actual Diversion	Return Flow	Stream Flow (AF)	Pre 1950 Acres Above YW	Pre 1950 Desired Diversion	Available Flow After YW Rights	Pre 1950 Actual Diversion	Return Flow	YW Reservoir Inflow	YW 1935 Acres Below YW	YW 1935 Desired Diversion	YW 1935 Actual Diversion	Return Flow	YW Res Spilled Flow	YW Res EOM Storage	YW Cr Entering Petrolia	FW Cr Above Petrolia
Jan-30	528	155							155						155					0	3795	0	374
Feb-30	858	251							251						251					0	4046	0	607
Mar-30	3211	940							940						940					486	4500	436	2271
Apr-30	3021	884		0.28					884						884					884	4500	884	2137
May-30	7321	2142	0.195	0.28	359	250	250	78	1970	205	143	957	143	44	1871	1455	1013	1013	314	858	4500	1172	5178
Jun-30	6674	1953	0.291	0.28	359	373	373	170	1750	205	213	269	213	97	1634	1455	1512	1512	689	122	4500	810	4721
Jul-30	11776	3446	0.515	0.28	359	660	660	309	3095	205	377	478	377	176	2894	1455	2676	2676	1252	218	4500	1470	8330
Aug-30	1843	539	0.409	0.50	359	294	294	237	482	205	168	-606	0	102	584	1455	1190	1190	959	0	3894	959	1303
Sep-30	29	9	0.171	0.50	359	123	9	104	104	205	70	-965	0	35	139	1455	498	498	515	0	3535	515	21
Oct-30	0	0		0.50				19	19					0	19				141	0	3554	141	0
Nov-30	0	0						1	1					0	1				30	0	3555	30	0
Dec-30	341	100							100						100					0	3655	0	241
Jan-31	972	284							284						284					0	3939	0	687
Feb-31	924	270							270						270					0	4210	0	653
Mar-31	507	148							148						148					0	4358	0	359
Apr-31	58	17		0.28					17						17					0	4375	0	41
May-31	5582	1634	0.195	0.28	359	250	250	78	1461	205	143	323	143	44	1363	1455	1013	1013	314	224	4500	538	3949
Jun-31	6575	1924	0.291	0.28	359	373	373	170	1721	205	213	240	213	97	1605	1455	1512	1512	689	93	4500	781	4651
Jul-31	11370	3328	0.515	0.28	359	660	660	309	2976	205	377	359	377	176	2775	1455	2676	2676	1252	99	4500	1351	8043
Aug-31	1843	539	0.409	0.50	359	294	294	237	482	205	168	-606	0	102	584	1455	1190	1190	959	0	3894	959	1303
Sep-31	0	0	0.171	0.50	359	123	0	103	103	205	70	-966	0	35	138	1455	498	498	515	0	3534	515	0
Oct-31	0	0		0.50				18	18					0	18				141	0	3552	141	0
Nov-31	0	0						0	0					0	0				30	0	3552	30	0
Dec-31	0	0							0						0					0	3552	0	0
Jan-32	0	0							0						0					0	3552	0	0
Feb-32	5	2							2						2					0	3553	0	4
Mar-32	0	0							0						0					0	3554	0	0
Apr-32	0	0		0.28					0						0					0	3554	0	0
May-32	6998	2048	0.195	0.28	359	250	250	78	1875	205	143	-84	0	0	1875	1455	1013	1013	314	0	4416	314	4950
Jun-32	21205	6205	0.291	0.28	359	373	373	170	6002	205	213	4406	213	66	5855	1455	1512	1512	689	4259	4500	4948	14999
Jul-32	16842	4929	0.515	0.28	359	660	660	309	4577	205	377	1948	377	163	4364	1455	2676	2676	1252	1687	4500	2939	11914
Aug-32	2059	603	0.409	0.50	359	294	294	237	546	205	168	-543	0	102	647	1455	1190	1190	959	0	3957	959	1457

Petrolia: Yellow Water Basin Model: Normal Storage = 4500 , Dead Storage = 50

(A) Date	(B) Petrolia Natural Inflow	(C) Yellow Water Above YW	(D) NIR Above Petrolia Ft	(E) Irrigation Eff(%)	(F) Pre 1935 Acres Above YW	(G) Pre 1935 Desired Diversion	(H) Pre 1935 Actual Diversion	(I) Return Flow	(J) Stream Flow (AF)	(K) Pre 1950 Acres Above YW	(L) Pre 1950 Desired Diversion	(M) Available Flow After YW Rights	(N) Pre 1950 Actual Diversion	(O) Return Flow	(P) YW Reservoir Inflow	(Q) YW 1935 Acres Below YW	(R) YW 1935 Desired Diversion	(S) YW 1935 Actual Diversion	(T) Return Flow	(U) YW Res Spilled Flow	(V) YW Res EOM Storage	(W) YW Cr Entering Petrolia	FW Cr Above Petrolia
Sep-32	0	0	0.171	0.50	359	123	0	103	103	205	70	-903	0	35	138	1455	498	498	515	0	3597	515	0
Oct-32	1	0		0.50				18	18					0	18				141	0	3615	141	0
Nov-32	1	0						0	0					0	0				30	0	3615	30	1
Dec-32	0	0							0						0					0	3615	0	0
Jan-33	0	0							0						0					0	3615	0	0
Feb-33	5	2							2						2					0	3617	0	4
Mar-33	1	0							0						0					0	3617	0	0
Apr-33	0	0		0.28					0						0					0	3617	0	0
May-33	5498	1609	0.195	0.28	359	250	250	78	1437	205	143	-460	0	0	1437	1455	1013	1013	314	0	4040	314	3889
Jun-33	3619	1059	0.291	0.28	359	373	373	170	856	205	213	-1116	0	0	856	1455	1512	1512	689	0	3384	689	2560
Jul-33	8304	2430	0.515	0.28	359	660	660	309	2079	205	377	-1713	0	0	2079	1455	2676	2676	1252	0	2787	1252	5874
Aug-33	1587	464	0.409	0.50	359	294	294	237	408	205	168	-2496	0	0	408	1455	1190	1190	959	0	2004	959	1123
Sep-33	0	0	0.171	0.50	359	123	0	103	103	205	70	-2891	0	0	103	1455	498	498	515	0	1609	515	0
Oct-33	1	0		0.50				18	18					0	18				141	0	1627	141	0
Nov-33	1	0						0	0					0	0				30	0	1627	30	1
Dec-33	0	0							0						0					0	1627	0	0
Jan-34	0	0							0						0					0	1627	0	0
Feb-34	5	2							2						2					0	1629	0	4
Mar-34	382	112							112						112					0	1740	0	270
Apr-34	0	0		0.28					0						0					0	1740	0	0
May-34	5492	1607	0.195	0.28	359	250	250	78	1435	205	143	-2338	0	0	1435	1455	1013	1013	314	0	2162	314	3885
Jun-34	3399	995	0.291	0.28	359	373	373	170	792	205	213	-3059	0	0	792	1455	1512	1512	689	0	1441	689	2404
Jul-34	8214	2404	0.515	0.28	359	660	660	309	2052	205	377	-3683	0	0	2052	1455	2676	2676	1252	0	817	1252	5810
Aug-34	1587	464	0.409	0.50	359	294	294	237	408	205	168	-4465	0	0	408	1455	1190	1175	956	0	50	956	1123
Sep-34	0	0	0.171	0.50	359	123	0	103	103	205	70	-4845	0	0	103	1455	498	103	434	0	50	434	0
Oct-34	1	0		0.50				18	18					0	18				85	0	68	85	0
Nov-34	1	0						0	0					0	0				6	0	68	6	1
Dec-34	0	0							0						0					0	68	0	0
Jan-35	0	0							0						0					0	68	0	0
Feb-35	5	2							2						2					0	70	0	4
Mar-35	1	0							0						0					0	70	0	0
Apr-35	0	0		0.28					0						0					0	70	0	0

Petrolia: Yellow Water Basin Model: Normal Storage = 4500 , Dead Storage = 50

(A) Date	(B) Petrolia Natural Inflow	(C) Yellow Water Above YW	(D) NIR Above Petrolia Ft	(E) Irrigation Eff(%)	(F) Pre 1935 Acres Above YW	(G) Pre 1935 Desired Diversion	(H) Pre 1935 Actual Diversion	(I) Return Flow	(J) Stream Flow (AF)	(K) Pre 1950 Acres Above YW	(L) Pre 1950 Desired Diversion	(M) Available Flow After YW Rights	(N) Pre 1950 Actual Diversion	(O) Return Flow	(P) YW Reservoir Inflow	(Q) YW 1935 Acres Below YW	(R) YW 1935 Desired Diversion	(S) YW 1935 Actual Diversion	(T) Return Flow	(U) YW Res Spilled Flow	(V) YW Res EOM Storage	(W) YW Cr Entering Petrolia	FW Cr Above Petrolia
May-35	5458	1609	0.195	0.28	359	250	250	78	1437	205	143	-4007	0	0	1437	1455	1013	1013	314	0	493	314	3889
Jun-35	3619	1059	0.291	0.28	359	373	373	170	856	205	213	-4663	0	0	856	1455	1512	1299	623	0	50	623	2560
Jul-35	8304	2430	0.515	0.28	359	660	660	309	2079	205	377	-5047	0	0	2079	1455	2676	2079	1021	0	50	1021	5874
Aug-35	1587	464	0.409	0.50	359	294	294	237	408	205	168	-5233	0	0	408	1455	1190	408	653	0	50	653	1123
Sep-35	0	0	0.171	0.50	359	123	0	103	103	205	70	-4845	0	0	103	1455	498	103	271	0	50	271	0
Oct-35	1	0		0.50				18	18					0	18				39	0	68	39	0
Nov-35	1	0						0	0					0	0				6	0	68	6	1
Dec-35	0	0							0						0					0	68	0	0
Jan-36	0	0							0						0					0	68	0	0
Feb-36	5	2							2						2					0	70	0	4
Mar-36	106	31							31						31					0	101	0	75
Apr-36	11	3		0.28					3						3					0	104	0	8
May-36	5503	1610	0.195	0.28	359	250	250	78	1438	205	143	-3971	0	0	1438	1455	1013	1013	314	0	529	314	3892
Jun-36	3375	988	0.291	0.28	359	373	373	170	785	205	213	-4699	0	0	785	1455	1512	1263	612	0	50	612	2388
Jul-36	8214	2404	0.515	0.28	359	660	660	309	2052	205	377	-5074	0	0	2052	1455	2676	2052	1005	0	50	1005	5810
Aug-36	1587	464	0.409	0.50	359	294	294	237	408	205	168	-5233	0	0	408	1455	1190	408	644	0	50	644	1123
Sep-36	0	0	0.171	0.50	359	123	0	103	103	205	70	-4845	0	0	103	1455	498	103	268	0	50	268	0
Oct-36	1	0		0.50				18	18					0	18				39	0	68	39	0
Nov-36	1	0						0	0					0	0				6	0	68	6	1
Dec-36	0	0							0						0					0	68	0	0
Jan-37	0	0							0						0					0	68	0	0
Feb-37	5	2							2						2					0	70	0	4
Mar-37	1	0							0						0					0	70	0	0
Apr-37	0	0		0.28					0						0					0	70	0	0
May-37	5492	1607	0.195	0.28	359	250	250	78	1435	205	143	-4009	0	0	1435	1455	1013	1013	314	0	491	314	3885
Jun-37	3375	988	0.291	0.28	359	373	373	170	784	205	213	-4736	0	0	784	1455	1512	1226	600	0	50	600	2387
Jul-37	8214	2404	0.515	0.28	359	660	660	309	2052	205	377	-5074	0	0	2052	1455	2676	2052	996	0	50	996	5810
Aug-37	1587	464	0.409	0.50	359	294	294	237	408	205	168	-5233	0	0	408	1455	1190	408	641	0	50	641	1123
Sep-37	0	0	0.171	0.50	359	123	0	103	103	205	70	-4845	0	0	103	1455	498	103	268	0	50	268	0
Oct-37	1	0		0.50				18	18					0	18				39	0	68	39	0
Nov-37	1	0						0	0					0	0				6	0	68	6	1
Dec-37	0	0							0						0					0	68	0	0

Petrolia: Yellow Water Basin Model: Normal Storage = 4500 , Dead Storage = 50

(A) Date	(B) Petrolia Natural Inflow	(C) Yellow Water Above YW	(D) NIR Above Petrolia Ft	(E) Irrigation Eff(%)	(F) Pre 1935 Acres Above YW	(G) Pre 1935 Desired Diversion	(H) Pre 1935 Actual Diversion	(I) Return Flow	(J) Stream Flow (AF)	(K) Pre 1950 Acres Above YW	(L) Pre 1950 Desired Diversion	(M) Available Flow After YW Rights	(N) Pre 1950 Actual Diversion	(O) Return Flow	(P) YW Reservoir Inflow	(Q) YW 1935 Acres Below YW	(R) YW 1935 Desired Diversion	(S) YW 1935 Actual Diversion	(T) Return Flow	(U) YW Res Spilled Flow	(V) YW Res EOM Storage	(W) YW Cr Entering Petrolia	FW Cr Above Petrolia
Jan-38	0	0							0						0					0	68	0	0
Feb-38	5	2							2						2					0	70	0	4
Mar-38	1	0							0						0					0	70	0	0
Apr-38	0	0		0.28					0						0					0	70	0	0
May-38	5530	1618	0.195	0.28	359	250	250	78	1446	205	143	-3997	0	0	1446	1455	1013	1013	314	0	503	314	3912
Jun-38	4371	1279	0.291	0.28	359	373	373	170	1076	205	213	-4434	0	0	1076	1455	1512	1512	689	0	66	689	3092
Jul-38	9998	2926	0.515	0.28	359	660	660	309	2574	205	377	-4535	0	0	2574	1455	2676	2591	1226	0	50	1226	7072
Aug-38	1639	480	0.409	0.50	359	294	294	237	423	205	168	-5217	0	0	423	1455	1190	423	787	0	50	787	1160
Sep-38	0	0	0.171	0.50	359	123	0	103	103	205	70	-4845	0	0	103	1455	498	103	321	0	50	321	0
Oct-38	1	0		0.50				18	18					0	18				40	0	68	40	0
Nov-38	1	0						0	0					0	0				6	0	68	6	1
Dec-38	196	57							57						57					0	125	0	139
Jan-39	175	51							51						51					0	177	0	123
Feb-39	232	68							68						68					0	244	0	164
Mar-39	1150	337							337						337					0	581	0	814
Apr-39	128	37		0.28					37						37					0	618	0	91
May-39	5705	1670	0.195	0.28	359	250	250	78	1497	205	143	-3398	0	0	1497	1455	1013	1013	314	0	1102	314	4035
Jun-39	5958	1743	0.291	0.28	359	373	373	170	1540	205	213	-3370	0	0	1540	1455	1512	1512	689	0	1130	689	4214
Jul-39	8831	2584	0.515	0.28	359	660	660	309	2233	205	377	-3813	0	0	2233	1455	2676	2676	1252	0	687	1252	6247
Aug-39	1590	465	0.409	0.50	359	294	294	237	408	205	168	-4595	0	0	408	1455	1190	1045	930	0	50	930	1125
Sep-39	0	0	0.171	0.50	359	123	0	103	103	205	70	-4845	0	0	103	1455	498	103	416	0	50	416	0
Oct-39	1	0		0.50				18	18					0	18				77	0	68	77	0
Nov-39	1	0						0	0					0	0				6	0	68	6	1
Dec-39	105	31							31						31					0	99	0	74
Jan-40	93	27							27						27					0	126	0	66
Feb-40	303	89							89						89					0	215	0	215
Mar-40	539	158							158						158					0	373	0	382
Apr-40	4	1		0.28					1						1					0	374	0	3
May-40	5530	1618	0.195	0.28	359	250	250	78	1446	205	143	-3694	0	0	1446	1455	1013	1013	314	0	806	314	3912
Jun-40	3562	1043	0.291	0.28	359	373	373	170	839	205	213	-4366	0	0	839	1455	1512	1512	689	0	134	689	2520
Jul-40	8214	2404	0.515	0.28	359	660	660	309	2052	205	377	-4990	0	0	2052	1455	2676	2136	1085	0	50	1085	5810
Aug-40	1587	464	0.409	0.50	359	294	294	237	408	205	168	-5233	0	0	408	1455	1190	408	686	0	50	686	1123

Petrolia: Yellow Water Basin Model: Normal Storage = 4500 , Dead Storage = 50

(A) Date	(B) Petrolia Natural Inflow	(C) Yellow Water Above YW	(D) NIR Above Petrolia Ft	(E) Irrigation Eff(%)	(F) Pre 1935 Acres Above YW	(G) Pre 1935 Desired Diversion	(H) Pre 1935 Actual Diversion	(I) Return Flow	(J) Stream Flow (AF)	(K) Pre 1950 Acres Above YW	(L) Pre 1950 Desired Diversion	(M) Available Flow After YW Rights	(N) Pre 1950 Actual Diversion	(O) Return Flow	(P) YW Reservoir Inflow	(Q) YW 1935 Acres Below YW	(R) YW 1935 Desired Diversion	(S) YW 1935 Actual Diversion	(T) Return Flow	(U) YW Res Spilled Flow	(V) YW Res EOM Storage	(W) YW Cr Entering Petrolia
Sep-40	0	0	0.171	0.50	359	123	0	103	103	205	70	-4845	0	0	103	1455	498	103	276	0	50	276
Oct-40	1	0		0.50				18	18					0	18				39	0	68	39
Nov-40	1	0						0	0					0	0				6	0	68	6
Dec-40	0	0							0						0					0	68	0
Jan-41	0	0							0						0					0	68	0
Feb-41	5	2							2						2					0	70	0
Mar-41	1	0							0						0					0	70	0
Apr-41	0	0		0.28					0						0					0	70	0
May-41	5494	1608	0.195	0.28	359	250	250	78	1435	205	143	-4008	0	0	1435	1455	1013	1013	314	0	492	314
Jun-41	3749	1097	0.291	0.28	359	373	373	170	894	205	213	-4626	0	0	894	1455	1512	1336	634	0	50	634
Jul-41	8541	2500	0.515	0.28	359	660	660	309	2148	205	377	-4978	0	0	2148	1455	2676	2148	1050	0	50	1050
Aug-41	2147	628	0.409	0.50	359	294	294	237	571	205	168	-5069	0	0	571	1455	1190	571	705	0	50	705
Sep-41	0	0	0.171	0.50	359	123	0	103	103	205	70	-4845	0	0	103	1455	498	103	300	0	50	300
Oct-41	2	1		0.50				18	18					0	18				49	0	68	49
Nov-41	15	4						0	4					0	4				6	0	72	6
Dec-41	1167	341							341						341					0	414	0
Jan-42	920	269							269						269					0	683	0
Feb-42	807	236							236						236					0	919	0
Mar-42	953	279							279						279					0	1198	0
Apr-42	5276	1544		0.28					1544						1544					0	2742	0
May-42	9422	2757	0.195	0.28	359	250	250	78	2585	205	143	-186	0	0	2585	1455	1013	1013	314	0	4314	314
Jun-42	14829	4340	0.291	0.28	359	373	373	170	4136	205	213	2438	213	66	3989	1455	1512	1512	689	2291	4500	2979
Jul-42	9615	2814	0.515	0.28	359	660	660	309	2462	205	377	-168	0	46	2509	1455	2676	2676	1252	0	4332	1252
Aug-42	2459	720	0.409	0.50	359	294	294	237	663	205	168	-675	0	20	683	1455	1190	1190	959	0	3825	959
Sep-42	167	49	0.171	0.50	359	123	49	112	112	205	70	-1061	0	0	112	1455	498	498	515	0	3439	515
Oct-42	1	0		0.50				24	25					0	25				141	0	3464	141
Nov-42	1	0						3	3					0	3				30	0	3467	30
Dec-42	621	182							182						182					0	3649	0
Jan-43	706	207							207						207					0	3855	0
Feb-43	1631	477							477						477					0	4333	0
Mar-43	2797	819							819						819					651	4500	651
Apr-43	811	237		0.28					237						237					237	4500	237

Petrolia: Yellow Water Basin Model: Normal Storage = 4500 , Dead Storage = 50

(A) Date	(B) Petrolia Natural Inflow	(C) Yellow Water Above YW	(D) NIR Above Petrolia Ft	(E) Irrigation Eff(%)	(F) Pre 1935 Acres Above YW	(G) Pre 1935 Desired Diversion	(H) Pre 1935 Actual Diversion	(I) Return Flow	(J) Stream Flow (AF)	(K) Pre 1950 Acres Above YW	(L) Pre 1950 Desired Diversion	(M) Available Flow After YW Rights	(N) Pre 1950 Actual Diversion	(O) Return Flow	(P) YW Reservoir Inflow	(Q) YW 1935 Acres Below YW	(R) YW 1935 Desired Diversion	(S) YW 1935 Actual Diversion	(T) Return Flow	(U) YW Res Spilled Flow	(V) YW Res EOM Storage	(W) YW Cr Entering Petrolia	FW Cr Above Petrolia
May-43	6071	1777	0.195	0.28	359	250	250	78	1604	205	143	591	143	44	1506	1455	1013	1013	314	492	4500	807	4295
Jun-43	15045	4403	0.291	0.28	359	373	373	170	4200	205	213	2718	213	97	4084	1455	1512	1512	689	2571	4500	3260	10642
Jul-43	10564	3091	0.515	0.28	359	660	660	309	2740	205	377	123	179	115	2676	1455	2676	2676	1252	0	4500	1252	7472
Aug-43	2175	636	0.409	0.50	359	294	294	237	579	205	168	-552	0	59	638	1455	1190	1190	959	0	3948	959	1538
Sep-43	0	0	0.171	0.50	359	123	0	103	103	205	70	-931	0	17	119	1455	498	498	515	0	3569	515	0
Oct-43	1	0		0.50				18	18					0	18				141	0	3587	141	0
Nov-43	1	0						0	0					0	0				30	0	3588	30	1
Dec-43	516	151							151						151					0	3739	0	365
Jan-44	404	118							118						118					0	3857	0	286
Feb-44	471	138							138						138					0	3995	0	333
Mar-44	1114	326							326						326					0	4321	0	788
Apr-44	100	29		0.28					29						29					0	4350	0	71
May-44	5578	1632	0.195	0.28	359	250	250	78	1460	205	143	297	143	44	1361	1455	1013	1013	314	198	4500	512	3945
Jun-44	7609	2227	0.291	0.28	359	373	373	170	2023	205	213	542	213	97	1907	1455	1512	1512	689	395	4500	1084	5382
Jul-44	9968	2917	0.515	0.28	359	660	660	309	2566	205	377	-51	0	60	2625	1455	2676	2676	1252	0	4449	1252	7051
Aug-44	2107	617	0.409	0.50	359	294	294	237	560	205	168	-661	0	20	580	1455	1190	1190	959	0	3839	959	1491
Sep-44	0	0	0.171	0.50	359	123	0	103	103	205	70	-1057	0	0	103	1455	498	498	515	0	3443	515	0
Oct-44	1	0		0.50				18	18					0	18				141	0	3461	141	0
Nov-44	1	0						0	0					0	0				30	0	3461	30	1
Dec-44	419	123							123						123					0	3584	0	296
Jan-45	380	111							111						111					0	3695	0	269
Feb-45	317	93							93						93					0	3788	0	224
Mar-45	527	154							154						154					0	3942	0	373
Apr-45	3	1		0.28					1						1					0	3943	0	2
May-45	5545	1623	0.195	0.28	359	250	250	78	1450	205	143	-120	0	0	1450	1455	1013	1013	314	0	4380	314	3922
Jun-45	5754	1684	0.291	0.28	359	373	373	170	1481	205	213	-151	0	0	1481	1455	1512	1512	689	0	4349	689	4070
Jul-45	8514	2492	0.515	0.28	359	660	660	309	2140	205	377	-687	0	0	2140	1455	2676	2676	1252	0	3813	1252	6022
Aug-45	1591	466	0.409	0.50	359	294	294	237	409	205	168	-1469	0	0	409	1455	1190	1190	959	0	3031	959	1125
Sep-45	0	0	0.171	0.50	359	123	0	103	103	205	70	-1864	0	0	103	1455	498	498	515	0	2636	515	0
Oct-45	1	0		0.50				18	18					0	18				141	0	2654	141	0
Nov-45	1	0						0	0					0	0				30	0	2654	30	1
Dec-45	190	55							55						55					0	2709	0	134

Petrolia: Yellow Water Basin Model: Normal Storage = 4500 , Dead Storage = 50

(A) Date	(B) Petrolia Natural Inflow	(C) Yellow Water Above YW	(D) NIR Above Petrolia Ft	(E) Irrigation Eff(%)	(F) Pre 1935 Acres Above YW	(G) Pre 1935 Desired Diversion	(H) Pre 1935 Actual Diversion	(I) Return Flow	(J) Stream Flow (AF)	(K) Pre 1950 Acres Above YW	(L) Pre 1950 Desired Diversion	(M) Available Flow After YW Rights	(N) Pre 1950 Actual Diversion	(O) Return Flow	(P) YW Reservoir Inflow	(Q) YW 1935 Acres Below YW	(R) YW 1935 Desired Diversion	(S) YW 1935 Actual Diversion	(T) Return Flow	(U) YW Res Spilled Flow	(V) YW Res EOM Storage	(W) YW Cr Entering Petrolia	FW Cr Above Petrolia
Jan-46	432	126							126						126					0	2826	0	305
Feb-46	426	125							125						125					0	2961	0	302
Mar-46	573	168							168						168					0	3128	0	405
Apr-46	6	2		0.28					2						2					0	3130	0	4
May-46	5580	1633	0.195	0.28	359	250	250	78	1460	205	143	-923	0	0	1460	1455	1013	1013	314	0	3577	314	3947
Jun-46	4477	1310	0.291	0.28	359	373	373	170	1107	205	213	-1328	0	0	1107	1455	1512	1512	689	0	3172	689	3167
Jul-46	8360	2447	0.515	0.28	359	660	660	309	2095	205	377	-1909	0	0	2095	1455	2676	2676	1252	0	2591	1252	5914
Aug-46	1587	464	0.409	0.50	359	294	294	237	408	205	168	-2692	0	0	408	1455	1190	1190	959	0	1808	959	1123
Sep-46	0	0	0.171	0.50	359	123	0	103	103	205	70	-3087	0	0	103	1455	498	498	515	0	1413	515	0
Oct-46	1	0		0.50				18	18					0	18				141	0	1431	141	0
Nov-46	1	0						0	0					0	0				30	0	1431	30	1
Dec-46	252	74							74						74					0	1505	0	178
Jan-47	213	62							62						62					0	1567	0	151
Feb-47	381	112							112						112					0	1679	0	270
Mar-47	2469	728							728						728					0	2407	0	1761
Apr-47	5421	1587		0.28					1587						1587					0	3994	0	3835
May-47	5838	1708	0.195	0.28	359	250	250	78	1536	205	143	16	24	7	1519	1455	1013	1013	314	0	4500	314	4129
Jun-47	5431	1589	0.291	0.28	359	373	373	170	1386	205	213	-121	0	5	1391	1455	1512	1512	689	0	4379	689	3841
Jul-47	8411	2462	0.515	0.28	359	660	660	309	2110	205	377	-685	0	2	2112	1455	2676	2676	1252	0	3815	1252	5950
Aug-47	1599	468	0.409	0.50	359	294	294	237	411	205	168	-1464	0	0	411	1455	1190	1190	959	0	3036	959	1131
Sep-47	0	0	0.171	0.50	359	123	0	103	103	205	70	-1859	0	0	103	1455	498	498	515	0	2641	515	0
Oct-47	1	0		0.50				18	18					0	18				141	0	2659	141	0
Nov-47	1	0						0	0					0	0				30	0	2659	30	1
Dec-47	203	59							59						59					0	2719	0	143
Jan-48	312	91							91						91					0	2810	0	221
Feb-48	339	99							99						99					0	2909	0	240
Mar-48	677	198							198						198					0	3107	0	479
Apr-48	83	24		0.28					24						24					0	3131	0	58
May-48	6698	1960	0.195	0.28	359	250	250	78	1788	205	143	-594	0	0	1788	1455	1013	1013	314	0	3906	314	4738
Jun-48	14689	4299	0.291	0.28	359	373	373	170	4095	205	213	1989	213	66	3948	1455	1512	1512	689	1842	4500	2531	10390
Jul-48	17400	5092	0.515	0.28	359	660	660	309	4741	205	377	2111	377	163	4527	1455	2676	2676	1252	1851	4500	3103	12308
Aug-48	2379	696	0.409	0.50	359	294	294	237	639	205	168	-449	0	102	741	1455	1190	1190	959	0	4051	959	1683

Petrolia: Yellow Water Basin Model: Normal Storage = 4500 , Dead Storage = 50 :

(A) Date	(B) Petrolia Natural Inflow	(C) Yellow Water Above YW	(D) NIR Above Petrolia Ft	(E) Irrigation Eff(%)	(F) Pre 1935 Acres Above YW	(G) Pre 1935 Desired Diversion	(H) Pre 1935 Actual Diversion	(I) Return Flow	(J) Stream Flow (AF)	(K) Pre 1950 Acres Above YW	(L) Pre 1950 Desired Diversion	(M) Available Flow After YW Rights	(N) Pre 1950 Actual Diversion	(O) Return Flow	(P) YW Reservoir Inflow	(Q) YW 1935 Acres Below YW	(R) YW 1935 Desired Diversion	(S) YW 1935 Actual Diversion	(T) Return Flow	(U) YW Res Spilled Flow	(V) YW Res EOM Storage	(W) YW Cr Entering Petrolia	FW Cr Above Petrolia
Sep-48	0	0	0.171	0.50	359	123	0	103	103	205	70	-809	0	35	138	1455	498	498	515	0	3691	515	0
Oct-48	0	0		0.50				18	18					0	18				141	0	3708	141	0
Nov-48	140	41						0	41					0	41				30	0	3749	30	99
Dec-48	261	76							76						76					0	3826	0	185
Jan-49	198	58							58						58					0	3884	0	140
Feb-49	820	240							240						240					0	4124	0	530
Mar-49	4798	1404							1404						1404					1028	4500	1028	3394
Apr-49	545	160		0.28					160						160					160	4500	160	386
May-49	6036	1766	0.195	0.28	359	250	250	78	1594	205	143	581	143	44	1495	1455	1013	1013	314	482	4500	796	4270
Jun-49	7002	2049	0.291	0.28	359	373	373	170	1846	205	213	365	213	97	1730	1455	1512	1512	689	218	4500	906	4953
Jul-49	11771	3445	0.515	0.28	359	660	660	309	3093	205	377	477	377	176	2893	1455	2676	2676	1252	216	4500	1468	8326
Aug-49	1913	560	0.409	0.50	359	294	294	237	503	205	168	-586	0	102	605	1455	1190	1190	959	0	3914	959	1353
Sep-49	0	0	0.171	0.50	359	123	0	103	103	205	70	-946	0	35	138	1455	498	498	515	0	3554	515	0
Oct-49	0	0		0.50				18	18					0	18				141	0	3572	141	0
Nov-49	0	0						0	0					0	0				30	0	3572	30	0
Dec-49	0	0							0						0					0	3572	0	0
Jan-50	0	0							0						0					0	3573	0	0
Feb-50	32	9							9						9					0	3582	0	23
Mar-50	1197	350							350						350					0	3932	0	847
Apr-50	794	232		0.28					232						232					0	4165	0	562
May-50	6011	1759	0.195	0.28	359	250	250	78	1587	205	143	238	143	44	1488	1455	1013	1013	314	139	4500	454	4252
Jun-50	7404	2167	0.291	0.28	359	373	373	170	1963	205	213	482	213	97	1847	1455	1512	1512	689	335	4500	1024	5237
Jul-50	12308	3602	0.515	0.28	359	660	660	309	3250	205	377	634	377	176	3050	1455	2676	2676	1252	374	4500	1626	8706
Aug-50	1948	570	0.409	0.50	359	294	294	237	513	205	168	-576	0	102	615	1455	1190	1190	959	0	3924	959	1378
Sep-50	0	0	0.171	0.50	359	123	0	103	103	205	70	-936	0	35	138	1455	498	498	515	0	3564	515	0
Oct-50	0	0		0.50				18	18					0	18				141	0	3582	141	0
Nov-50	0	0						0	0					0	0				30	0	3582	30	0
Dec-50	146	43							43						43					0	3625	0	103

APPENDIX A
YELLOW WATER CREEK BASIN MODEL
COLUMN DESCRIPTIONS

A. Date.

B. Petrolia Natural inflow in Acre Feet (AF): same as Table 1.

C. Yellow Water Creek above Yellow Water Reservoir in AF: equal to Col. B x $(55/612)^{0.51}$.

D. Net irrigation requirement above Petrolia in feet: from SCS Irrigation Guide.

E. Irrigation Efficiency.

F. Pre-1935 acres above Yellow Water.

G. Pre-1935, desired diversion in AF: equal to Col. F x Col. D / Col. E.

H. Pre-1935 actual diversion in AF: equal to the lesser of Col. C and Col. G.

I. Pre-1935 return flow in AF: For each month's diversion, the amount that returns to the creek is equal to the diversion minus consumptive use and irrecoverable loss, or Col. H x (0.9 - Col. E). This volume is distributed among the next few months according to the pattern: 50% in the first month, 35% in the second month, 15% in the third month. For example, the August return flow is equal to 0.5 x Col. H August x (0.9 - Col. E August) + 0.35 x Col. H July x (0.9 - Col. E July) + 0.15 x Col. H June x (0.9 - Col E June).

J. Streamflow in AF: equal to Col. C - Col. H + Col. I.

K. Pre-1950 acres above Yellow Water.

L. Pre-1950 desired diversion in AF: equal to Col. K x Col. D / Col. E.

M. Available flow in AF after 1935 Yellow Water rights have been satisfied: equal to (Col. J + Col. V previous - normal pool storage - Col. R + return flows from Pre-1950 diversions in the previous two months. Normal pool storage here is 4500 AF.

N. Pre-1950 actual diversion in AF: If Col. M is less than or equal to zero, the diversion here is set equal to zero. If not, the Pre-1950 depletion is set equal to Col. M, where depletion is the diversion minus return flow for the present month. Since return flow for the present month is equal to diversion x 0.5 x (0.9 - Col. E), diversion can be solved for directly by dividing Col. M by the quantity [1 - 0.5 x (0.9 - Col. E)]. The actual Pre-1950 diversion is equal to the lesser of this quantity and Col. L.

O. Pre-1950 return flow in AF: same as Col. I with Col. N substituted for Col. H.

P. Yellow Water Reservoir inflow in AF: equal to Col. J - Col. N + Col. O.

Q. Yellow Water 1935 acres below Yellow Water.

R. Yellow Water 1935 desired diversion in AF: equal to Col. O x Col. D / Col. E.

S. Yellow Water 1935 actual diversion in AF: equal to the lesser of Col. R and (Col. P + Col. V for the previous month - dead storage). Dead storage here is equal to 50 AF.

T. Yellow Water 1935 return flow in AF: same as Col. I with Col. S substituted for Col. H.

U. Yellow Water Reservoir spilled flow in AF: equal to the amount that (Col. V previous month + Col. P - Col. S) exceeds the normal pool storage, if any.

V. Yellow Water Reservoir end of month storage in AF: equal to Col. V previous + Col. P - Col. S - Col. U.

W. Yellow Water Creek entering Petrolia in AF: equal to Col. T + Col. U.

X. Flatwillow Creek inflow to Petrolia model in AF: equal to Col. B - Col. C.

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B20: (F0) 11575.4796164
C20: (F0) [W10] +B20*(55/612)^0.51
D20: (F3) [W9] 0.515
E20: (F2) [W10] 0.28
F20: 359
G20: [W11] +F20*D20/E20
H20: @IF(C20>G20,G20,C20)
I20: 0.5*H20*(0.9-$E20)+0.35*H19*(0.9-$E19)+0.15*H18*(0.9-$E18)
J20: +C20-H20+I20
K20: 205
L20: [W10] +K20*D20/E20
M20: [W10] +J20+V19-$G$1-R20+0.35*N19*(0.9-E19)+0.15*N18*(0.9-E18)
N20: [W10] @IF(M20>0,@IF(M20/(0.55+0.5*E20)>L20,L20,M20/(0.55+0.5*E20)),0)
O20: 0.5*N20*(0.9-$E20)+0.35*N19*(0.9-$E19)+0.15*N18*(0.9-$E18)
P20: +J20-N20+O20
Q20: 1455
R20: [W10] +Q20*D20/E20
S20: [W10] @IF(P20+V19-$J$1>R20,R20,P20+V19-$J$1)
T20: 0.5*S20*(0.9-$E20)+0.35*S19*(0.9-$E19)+0.15*S18*(0.9-$E18)
U20: @IF(V19+P20-S20>$G$1,V19+P20-S20-$G$1,0)
V20: +V19+P20-S20-U20
W20: +U20+T20
X20: +B20-C20
0
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APPENDIX B

FLATWILLOW CREEK BASIN MODEL

Petrolia Normal Storage (AF) = 8380 Dead Storage = 0

(A) Date	(B) NIR Above Petrolia	(C) Eff Above Petrolia	(D) YW Cr Entering Petrolia	(E) FW Cr Above Petrolia	(F) Pre 1950 Acres Abv Petrolia	(G) Pre 1950 Desired Diversion	(H) Pre 1950 Actual Diversion	(I) Return Flow	(J) Stream Flow	(K) Post 1950 Acres Abv Petrolia	(L) Post 1950 Desired Diversion	(M) Available Flow After Pet Rights	(N) Post 1950 Actual Diversion	(O) Return Flow	(P) Petrolia Reservoir Inflow	(Q) NIR Below Petrolia	(R) Pet 1950 Acres Below Res	(S) Pet 1950 Desired Diversion	(T) Pet 1950 Actual Diversion	(U) Spilled Flow	(V) Petrolia Res EOM Storage	(W) Pet. 1950 Return Flow	(X) Stream Flow	(Y) Pre 1950 Damscheo Acres	(Z) Damscheo Desired Diversion	(AA) Damscheo Actual Diversion	(AB) Damscheo Return Flow	(AC) Stream Flow	(AD) Pre 1950 Damscheo Shortage	(AE) Pet. 1950 Total Ann. Diversion	(AF) Pet. 1950 Total Ann Shortage	(AG) Weibull Plotting Position	(AH) Sorted Pet Ann Yields
																					8380												
Jan-22			334	806					806						1140					1140	8380		1140						1140				0.033	19337
Feb-22			232	560					560						791					791	8380		791						791				0.067	19337
Mar-22			2474	5981					5981						8455					8455	8380		8455						8455				0.100	19337
Apr-22		0.28	1393	3367					3367						4760					4760	8380		4760						4760				0.133	19337
May-22	0.195	0.28	2389	8119	11107	7735	7735	2398	2782	1403	977	977	977	303	4497	0.174	4890	3039	3039	1458	8380	434	1892	165	103	103	32	1822	0			0.167	19337
Jun-22	0.291	0.28	5653	16427	11107	11543	11543	5257	10141	1403	1458	1458	1458	664	15000	0.264	4890	4611	4611	10389	8380	963	11352	165	156	156	70	11267	0			0.200	19337
Jul-22	0.515	0.28	1411	8188	11107	20429	8188	5763	5763	1403	2581	0	0	407	7581	0.471	4890	8226	8226	0	7735	1768	1768	165	278	278	129	1619	0			0.233	19337
Aug-22	0.409	0.50	959	1214	11107	9086	1214	3093	3093	1403	1148	102	102	156	4107	0.354	4890	3462	3462	0	8380	1340	1340	165	117	117	98	1321	0	19337	0	0.267	19337
Sep-22	0.171	0.50	515	0	11107	3799	0	932	932	1403	480	480	480	116	1077					1077	8380	576	1653				42	1695				0.300	19337
Oct-22		0.50	141	0				73	73					73	288					288	8380	96	383				7	390				0.333	19337
Nov-22			30	605				0	605					29	664					664	8380		664				0	664				0.367	19337
Dec-22			0	827					827						827					827	8380		827					827				0.400	19337
Jan-23			0	941					941						941					941	8380		941					941				0.433	19337
Feb-23			274	672					672						946					946	8380		946					946				0.467	19337
Mar-23			508	1210					1210						1710					1710	8380		1710					1710				0.500	19337
Apr-23		0.28	879	2123					2123						3002					3002	8380		3002					3002				0.533	19337
May-23	0.195	0.28	1218	5298	11107	7735	5298	1648	1648	1403	977	0	0	0	2858	0.174	4890	3039	3039	0	8380	434	434	165	103	103	32	364	0			0.567	19173
Jun-23	0.291	0.28	8489	23281	11107	11543	11543	4726	16464	1403	1458	1458	1458	452	23947	0.264	4890	4611	4611	19156	8380	963	20120	165	156	156	70	20034	0			0.600	19072
Jul-23	0.515	0.28	9668	28126	11107	20429	20429	9330	17827	1403	2581	2581	2581	1116	25223	0.471	4890	8226	8226	16997	8380	1768	18764	165	278	278	129	18616	0			0.633	18913
Aug-23	0.409	0.50	2305	6346	11107	9086	6346	6776	6776	1403	1148	1148	1148	925	8859	0.354	4890	3462	3462	5397	8380	1340	6737	165	117	117	98	6718	0	19337	0	0.667	17821
Sep-23	0.171	0.50	1887	2568	11107	3799	2568	3382	3382	1403	480	480	480	497	4486					4486	8380	576	4982				42	5024				0.700	14484
Oct-23		0.50	1401	2913				740	3653					136	5190					5190	8380	96	5286				7	5293				0.733	13588
Nov-23			1131	2635				154	2789					29	3949					3949	8380		3949				0	3949				0.767	12401
Dec-23			862	2883					2883						2945					2945	8380		2945					2945				0.800	12129
Jan-24			695	1680					1680						2375					2375	8380		2375					2375				0.833	12092
Feb-24			556	1344					1344						1900					1900	8380		1900					1900				0.867	11336
Mar-24			1026	2488					2488						3506					3506	8380		3506					3506				0.900	11224
Apr-24		0.28	3364	8131					8131						11495					11495	8380		11495					11495				0.933	10929
May-24	0.195	0.28	3987	11983	11107	7735	7735	2398	6646	1403	977	977	977	303	9959	0.174	4890	3039	3039	6928	8380	434	7355	165	103	103	32	7284	0			0.967	10810
Jun-24	0.291	0.28	4347	13369	11107	11543	11543	5257	6982	1403	1458	1458	1458	664	10535	0.264	4890	4611	4611	5924	8380	963	6887	165	156	156	70	6802	0				
Jul-24	0.515	0.28	2365	10493	11107	20429	10493	6477	6477	1403	2581	1483	1483	867	8226	0.471	4890	8226	8226	0	8380	1768	1768	165	278	278	129	1619	0				
Aug-24	0.409	0.50	959	2314	11107	9086	2314	3813	3813	1403	1148	1148	1148	687	4312	0.354	4890	3462	3462	850	8380	1340	2198	165	117	117	98	2171	0	19337	0		
Sep-24	0.171	0.50	515	522	11107	3799	522	1404	1404	1403	480	480	480	395	1834					1834	8380	576	2410				42	2452					
Oct-24		0.50	141	312				212	524					136	801					801	8380	96	897				7	904					
Nov-24			194	1022				31	1053					29	1276					1276	8380		1276				0	1276					
Dec-24			512	1236					1236						1748					1748	8380		1748					1748					
Jan-25			428	1035					1035						1463					1463	8380		1463					1463					
Feb-25			580	1210					1210						1710					1710	8380		1710					1710					
Mar-25			1368	3306					3306						4674					4674	8380		4674					4674					
Apr-25		0.28	973	2352					2352						3325					3325	8380		3325					3325					
May-25	0.195	0.28	818	4323	11107	7735	4323	1340	1340	1403	977	0	0	0	2158	0.174	4890	3039	3039	0	7499	434	434	165	103	103	32	364	0				
Jun-25	0.291	0.28	1133	5500	11107	11543	5500	2643	2643	1403	1458	0	0	0	3776	0.264	4890	4611	4611	0	6665	963	963	165	156	156	70	878	0				
Jul-25	0.515	0.28	1252	7082	11107	20429	7082	3791	3791	1403	2581	0	0	0	5043	0.471	4890	8226	8226	0	3402	1768	1768	165	278	278	129	1619	0				
Aug-25	0.409	0.50	959	1139	11107	9086	1139	2276	2276	1403	1148	0	0	0	3235	0.354	4890	3462	3462	0	3255	1340	1340	165	117	117	98	1321	0	19337	0		
Sep-25	0.171	0.50	515	0	11107	3799	0	818	818	1403	480	0	0	0	1333					0	4589	576	576				42	618					
Oct-25		0.50	141	0				68	69					0	210					0	4798	96	96				7	103					
Nov-25			30	456				0	456					0	486					0	5284		0				0	0					
Dec-25			0	531					531						531					0	5815		0					0					
Jan-26			0	331					331						331					0	6146		0					0					
Feb-26			0	298					298						298					0	6444		0					0					

Petrolia Normal Storage (AF) = 8380 , Dead Storage = 0

(A) Date	(B) NIR Above Petrolia	(C) Eff Above Petrolia	(D) YW Cr Entering Petrolia	(E) FW Cr Above Petrolia	(F) Pre 1950 Acres Abv Petrolia	(G) Pre 1950 Desired Diversion	(H) Pre 1950 Actual Diversion	(I) Return Flow	(J) Stream Flow	(K) Post 1950 Acres Abv Petrolia	(L) Post 1950 Desired Diversion	(M) Available Flow After Pet Rights	(N) Post 1950 Actual Diversion	(O) Return Flow	(P) Petrolia Reservoir Inflow	(Q) NIR Below Petrolia	(R) Pet 1950 Acres Below Res	(S) Pet 1950 Desired Diversion	(T) Pet 1950 Actual Diversion	(U) Spilled Flow	(V) Petrolia Res EOM Storage	(W) Pet. 1950 Return Flow	(X) Stream Flow	(Y) Pre 1950 Damschen Acres	(Z) Damschen Desired Diversion	(AA) Damschen Actual Diversion	(AB) Damschen Return Flow	(AC) Stream Flow	(AD) Pre 1950 Damschen Shortage	(AE) Pet. 1950 Total Ann. Diversion	(AF) Pet. 1950 Total Ann Shortage	(AG) Weibull Plotting Position	(AH) Sorted Pet Ann Yields
Mar-26			0	331					331						331					0	6775		0					0					
Apr-26		0.28	0	444					444						444					0	7218		0					0					
May-26	0.195	0.28	314	3471	11107	7735	3471	1076	1076	1403	977	0	0	0	1390	0.174	4890	3039	3039	0	5570	434	434	165	103	103	32	364	0				
Jun-26	0.291	0.28	689	4062	11107	11543	4062	2013	2013	1403	1458	0	0	0	2701	0.264	4890	4611	4611	0	3660	963	963	165	156	156	70	878	0				
Jul-26	0.515	0.28	1252	7098	11107	20429	7098	3405	3405	1403	2581	0	0	0	4657	0.471	4890	8226	8226	0	91	1768	1768	165	278	278	129	1619	0				
Aug-26	0.409	0.50	959	1139	11107	9086	1139	2146	2146	1403	1148	0	0	0	3105	0.354	4890	3462	3197	0	0	1316	1316	165	117	117	98	1297	8	19072	265		
Sep-26	0.171	0.50	515	0	11107	3799	0	820	820	1403	480	0	0	0	1335					0	1335	559	559				42	601					
Oct-26		0.50	141	588				68	656					0	797					0	2132	88	88				7	95					
Nov-26			30	0				0	0					0	30					0	2162		0				0	0					
Dec-26			0	289					289						289					0	2451		0					0					
Jan-27			0	202					202						202					0	2652		0					0					
Feb-27			0	181					181						181					0	2834		0					0					
Mar-27			662	3360					3360						4022					0	6856		0					0					
Apr-27		0.28	681	1451					1451						2052					528	8380		520					528					
May-27	0.195	0.28	8102	21929	11107	7735	7735	2398	16591	1403	977	977	977	383	24019	0.174	4890	3039	3039	20980	8380	434	21415	165	103	103	32	21344	0				
Jun-27	0.291	0.28	7433	28728	11107	11543	11543	5257	14441	1403	1458	1458	1458	664	21080	0.264	4890	4611	4611	16469	8380	963	17432	165	156	156	70	17347	0				
Jul-27	0.515	0.28	2270	10264	11107	20429	10264	6406	6406	1403	2581	1244	1244	793	8226	0.471	4890	8226	8226	0	8380	1768	1768	165	278	278	129	1619	0				
Aug-27	0.409	0.50	959	1925	11107	9086	1925	3686	3686	1403	1148	1148	1148	635	4133	0.354	4890	3462	3462	671	8380	1340	2011	165	117	117	98	1992	0	19337	0		
Sep-27	0.171	0.50	515	855	11107	3799	855	1395	1395	1403	480	480	480	372	1803					1803	8380	576	2379				42	2421					
Oct-27		0.50	141	688				235	924					136	1201					1201	8380	96	1296				7	1303					
Nov-27			509	1465				51	1517					29	2055					2055	8380		2055				0	2055					
Dec-27			584	1411					1411						1995					1995	8380		1995					1995					
Jan-28			500	1210					1210						1710					1710	8380		1710					1710					
Feb-28			417	1008					1008						1425					1425	8380		1425					1425					
Mar-28			898	2150					2150						3048					3048	8380		3048					3048					
Apr-28		0.28	948	2271					2271						3211					3211	8380		3211					3211					
May-28	0.195	0.28	1071	4934	11107	7735	4934	1530	1530	1403	977	0	0	0	2601	0.174	4890	3039	3039	0	7942	434	434	165	103	103	32	364	0				
Jun-28	0.291	0.28	689	4242	11107	11543	4242	2386	2386	1403	1458	0	0	0	3075	0.264	4890	4611	4611	0	6406	963	963	165	156	156	70	878	0				
Jul-28	0.515	0.28	1743	9848	11107	20429	9848	4184	4184	1403	2581	0	8	0	5928	0.471	4890	8226	8226	0	4108	1768	1768	165	278	278	129	1619	0				
Aug-28	0.409	0.50	959	1298	11107	9086	1298	2618	2618	1403	1148	0	0	0	3577	0.354	4890	3462	3462	8	4223	1340	1340	165	117	117	98	1321	0	19337	0		
Sep-28	0.171	0.50	515	86	11107	3799	86	1040	1040	1403	480	0	0	0	1555					0	5778	576	576				42	618					
Oct-28		0.50	141	0				90	90					0	231					0	6089	96	96				7	103					
Nov-28			30	343				5	348					0	378					0	6388		0				0	0					
Dec-28			0	470					470						470					0	6858		0					0					
Jan-29			0	413					413						413					0	7271		0					0					
Feb-29			0	373					373						373					0	7644		0					0					
Mar-29			1661	4704					4704						6365					5629	8380		5629					5629					
Apr-29		0.28	603	1458					1458						2061					2061	8380		2061					2061					
May-29	0.195	0.28	1513	6003	11107	7735	6003	1861	1861	1403	977	486	486	151	3039	0.174	4890	3039	3039	0	8380	434	434	165	103	103	32	364	0				
Jun-29	0.291	0.28	1953	7483	11107	11543	7483	3622	3622	1403	1458	1458	1458	557	4675	0.264	4890	4611	4611	64	8380	963	1027	165	156	156	70	942	0				
Jul-29	0.515	0.28	1252	7398	11107	20429	7398	4475	4475	1403	2581	0	0	362	6089	0.471	4890	8226	8226	0	6243	1768	1768	165	278	278	129	1619	0				
Aug-29	0.409	0.50	959	1139	11107	9086	1139	2529	2529	1403	1148	0	0	136	3624	0.354	4890	3462	3462	0	6405	1340	1340	165	117	117	98	1321	8	19337	0		
Sep-29	0.171	0.50	515	0	11107	3799	0	848	848	1403	480	0	0	0	1363					0	7768	576	576				42	618					
Oct-29		0.50	141	0				68	69					0	210					0	7978	96	96				7	103					
Nov-29			30	181				0	181					0	211					0	8188		0				0	0					
Dec-29			0	381					381						381					189	8380		189					189					
Jan-30			0	374					374						374					374	8380		374					374					
Feb-30			0	607					607						607					607	8380		607					607					
Mar-30			486	2271					2271						2757					2757	8380		2757					2757					
Apr-30		0.28	484	2137					2137						3021					3021	8380		3021					3021					
May-30	0.195	0.28	1172	5178	11107	7735	5178	1605	1605	1403	977	0	0	0	2777	0.174	4890	3039	3039	0	8119	434	434	165	103	103	32	364	0				

Petrolia Normal Storage (AF) = 8380 , Dead Storage = 0

(A) Date	(B) NIR Above Petrolia	(C) Elf Above Petrolia	(D) YW Cr Entering Petrolia	(E) FW Cr Above Petrolia	(F) Pre 1950 Acres Abv Petrolia	(G) Pre 1950 Desired Diversion	(H) Pre 1950 Actual Diversion	(I) Return Flow	(J) Stream Flow	(K) Post 1950 Acres Abv Petrolia	(L) Post 1950 Desired Diversion	(M) Available Flow After Pet Rights	(N) Post 1950 Actual Diversion	(O) Return Flow	(P) Petrolia Reservoir Inflow	(Q) NIR Below Petrolia	(R) Pet 1950 Acres Below Res	(S) Pet 1950 Desired Diversion	(T) Pet 1950 Actual Diversion	(U) Spilled Flow	(V) Petrolia Res EOM Storage	(W) Pet. 1950 Return Flow	(X) Stream Flow	(Y) Pre 1950 Damschen Acres	(Z) Damschen Desired Diversion	(AA) Damschen Actual Diversion	(AB) Damschen Return Flow	(AC) Stream Flow	(AD) Pre 1950 Damschen Shortage	(AE) Pet. 1950 Total Ann. Diversion	(AF) Pet. 1950 Total Ann Shortage	(AG) Weibull Plotting Position	(AH) Sorted Pet Ann Yields
Jun-30	0.291	0.28	618	4721	11107	11543	4721	2587	2587	1403	1458	0	0	0	3397	0.264	4890	4611	4611	0	6905	963	963	165	156	156	70	878	0				
Jul-30	0.515	0.28	1470	8330	11107	20429	8330	4088	4088	1403	2581	0	0	0	5558	0.471	4890	8226	8226	0	4238	1768	1768	165	278	278	129	1619	0				
Aug-30	0.409	0.50	959	1303	11107	9886	1303	2507	2507	1403	1148	0	0	0	3467	0.354	4890	3462	3462	0	4243	1340	1340	165	117	117	98	1321	0	19337	0		
Sep-30	0.171	0.50	515	21	11107	3799	21	961	961	1403	480	0	0	0	1476					0	5719	576	576				42	618					
Oct-30		0.50	141	0				81	81					0	222					0	5941	96	96				7	103					
Nov-30			30	0				1	2					0	31					0	5973		0				0	0					
Dec-30			0	241					241						241					0	6214		0					0				
Jan-31			0	687					687						687					0	6902		0					0				
Feb-31			0	653					653						653					0	7555		0					0				
Mar-31			0	359					359						359					0	7914		0					0				
Apr-31		0.28	0	41					41						41					0	7955		0					0				
May-31	0.195	0.28	538	3949	11107	7735	3949	1224	1224	1403	977	0	0	0	1762	0.174	4890	3039	3039	0	6679	434	434	165	103	103	32	364	0				
Jun-31	0.291	0.28	781	4651	11107	11543	4651	2299	2299	1403	1458	0	0	0	3080	0.264	4890	4611	4611	0	5148	963	963	165	156	156	70	878	0				
Jul-31	0.515	0.28	1351	8043	11107	20429	8043	3870	3870	1403	2581	0	0	0	5221	0.471	4890	8226	8226	0	2143	1768	1768	165	278	278	129	1619	0				
Aug-31	0.409	0.50	959	1303	11107	9886	1383	2439	2439	1403	1148	0	0	0	3398	0.354	4890	3462	3462	0	2079	1340	1340	165	117	117	98	1321	0	19337	0		
Sep-31	0.171	0.50	515	0	11107	3799	0	931	931	1403	480	0	0	0	1446					0	3525	576	576				42	618					
Oct-31		0.50	141	0				78	79					0	220					0	3744	96	96				7	103					
Nov-31			30	0				0	0					0	30					0	3774		0				0	0				
Dec-31			0	0					0						0					0	3775		0					0				
Jan-32			0	0					0						0					0	3775		0					0				
Feb-32			0	4					4						4					0	3779		0					0				
Mar-32			0	0					0						0					0	3779		0					0				
Apr-32		0.28	0	0					0						0					0	3779		0					0				
May-32	0.195	0.28	314	4950	11107	7735	4950	1534	1534	1403	977	0	0	0	1849	0.174	4890	3039	3039	0	2589	434	434	165	103	103	32	364	0				
Jun-32	0.291	0.28	4948	14999	11107	11543	11543	4653	8109	1403	1458	1458	1458	452	12050	0.264	4890	4611	4611	1649	8380	963	2612	165	156	156	70	2527	0				
Jul-32	0.515	0.28	2939	11914	11107	20429	11914	6658	6658	1403	2581	2447	2447	1075	8226	0.471	4890	8226	8226	0	8380	1768	1768	165	278	278	129	1619	0				
Aug-32	0.409	0.50	959	1457	11107	9886	1457	3950	3950	1403	1148	1148	1148	896	4658	0.354	4890	3462	3462	1196	8380	1340	2536	165	117	117	98	2517	0	19337	0		
Sep-32	0.171	0.50	515	0	11107	3799	0	1312	1312	1403	480	480	480	484	1831					1831	8380	576	2408				42	2450					
Oct-32		0.50	141	0				87	88					136	365					365	8380	96	461				7	468					
Nov-32			30	1				0	1					29	59					59	8380		59				0	59				
Dec-32			0	0					0						0					0	8380		0					0				
Jan-33			0	0					0						0					0	8380		0					0				
Feb-33			0	4					4						4					4	8380		4					4				
Mar-33			0	0					0						0					0	8380		0					0				
Apr-33		0.28	0	0					0						0					0	8380		0					0				
May-33	0.195	0.28	314	3889	11107	7735	3889	1206	1206	1403	977	0	0	0	1520	0.174	4890	3039	3039	0	6861	434	434	165	103	103	32	364	0				
Jun-33	0.291	0.28	689	2560	11107	11543	2560	1637	1637	1403	1458	0	0	0	2326	0.264	4890	4611	4611	0	4577	963	963	165	156	156	70	878	0				
Jul-33	0.515	0.28	1252	5874	11107	20429	5874	2738	2738	1403	2581	0	0	0	3990	0.471	4890	8226	8226	0	341	1768	1768	165	278	278	129	1619	0				
Aug-33	0.409	0.50	959	1123	11107	9886	1123	1737	1737	1403	1148	0	0	0	2697	0.354	4890	3462	3838	0	0	1301	1301	165	117	117	98	1282	0	18913	425		
Sep-33	0.171	0.50	515	0	11107	3799	0	703	703	1403	480	0	0	0	1218					0	1218	549	549				42	591					
Oct-33		0.50	141	0				67	68					0	209					0	1427	84	84				7	91					
Nov-33			30	1				0	1					0	30					0	1458		0				0	0				
Dec-33			0	0					0						0					0	1458		0					0				
Jan-34			0	0					0						0					0	1458		0					0				
Feb-34			0	4					4						4					0	1462		0					0				
Mar-34			0	270					270						270					0	1732		0					0				
Apr-34		0.28	0	0					0						0					0	1732		0					0				
May-34	0.195	0.28	314	3885	11107	7735	3885	1204	1204	1403	977	0	0	0	1518	0.174	4890	3039	3039	0	212	434	434	165	103	103	32	364	0				
Jun-34	0.291	0.28	689	2404	11107	11543	2404	1588	1588	1403	1458	0	0	0	2277	0.264	4890	4611	2489	0	-0	660	660	165	156	156	70	575	0				
Jul-34	0.515	0.28	1252	5810	11107	20429	5810	2684	2684	1403	2581	0	0	0	3936	0.471	4890	8226	3936	0	-0	942	942	165	278	278	129	794	0				
Aug-34	0.409	0.50	956	1123	11107	9886	1123	1709	1709	1403	1148	0	0	0	2665	0.354	4890	3462	2665	0	-0	746	746	165	117	117	98	728	0	12129	7208		

Petrolia Normal Storage (AF) = 8380 . Dead Storage = 0

(A) Date	(B) NIR Above Petrolia	(C) Eff Above Petrolia	(D) Yld Cr Entering Petrolia	(E) Fld Cr Above Petrolia	(F) Pre 1950 Acres Abv Petrolia	(G) Pre 1950 Desired Diversion	(H) Pre 1950 Actual Diversion	(I) Return Flow	(J) Stream Flow	(K) Post 1950 Acres Abv Petrolia	(L) Post 1950 Desired Diversion	(M) Available Flow After Pet Rights	(N) Post 1950 Actual Diversion	(O) Return Flow	(P) Petrolia Reservoir Inflow	(Q) NIR Below Petrolia	(R) Pet 1950 Acres Below Res	(S) Pet 1950 Desired Diversion	(T) Pet 1950 Actual Diversion	(U) Spilled Flow	(V) Petrolia Res EOM Storage	(W) Pet. 1950 Return Flow	(X) Stream Flow	(Y) Pre 1950 Danschen Acres	(Z) Danschen Desired Diversion	(AA) Danschen Actual Diversion	(AB) Danschen Return Flow	(AC) Stream Flow	(AD) Pre 1950 Danschen Shortage	(AE) Pet. 1950 Total Ann. Diversion	(AF) Pet. 1950 Total Ann Shortage	(AG) Weibull Plotting Position	(AH) Sorted Pet Ann Yields
Sep-34	0.171	0.50	434	0	11107	3799	0	698	698	1403	480	0	0	0	1131					0	1131	341	341				42	383					
Oct-34		0.50	85	0				67	68					0	153					0	1284	74	74				7	81					
Nov-34			6	1				0	1					0	7					0	1291		0				0	0					
Dec-34			0	0					0						0					0	1291		0					0				
Jan-35			0	0					0						0					0	1291		0					0				
Feb-35			0	4					4						4					0	1295		0					0				
Mar-35			0	0					0						0					0	1295		0					0				
Apr-35		0.28	0	0					0						0					0	1295		0					0				
May-35	0.195	0.28	314	3889	11107	7735	3889	1206	1206	1403	977	0	0	0	1520	0.174	4890	3039	2815	0	-0	402	402	165	103	103	32	332	0				
Jun-35	0.291	0.28	623	2560	11107	11543	2560	1637	1637	1403	1458	0	0	0	2260	0.264	4890	4611	2260	0	-0	605	605	165	156	156	70	520	0				
Jul-35	0.515	0.28	1021	5874	11107	20429	5874	2738	2738	1403	2581	0	0	0	3759	0.471	4890	8226	3759	0	-0	884	884	165	278	278	129	736	0				
Aug-35	0.409	0.50	653	1123	11107	9086	1123	1737	1737	1403	1146	0	0	0	2391	0.354	4890	3462	2391	0	-0	694	694	165	117	117	98	675	0	11224	8113		
Sep-35	0.171	0.50	271	0	11107	3799	0	703	703	1403	480	0	0	0	974					6	974	316	316				42	358					
Oct-35		0.50	39	0				67	68					0	107					0	1081	66	66				7	73					
Nov-35			6	1				0	1					0	7					0	1088		0				0	0				
Dec-35			0	0					0						0					0	1088		0					0				
Jan-36			0	0					0						0					0	1088		0					0				
Feb-36			0	4					4						4					0	1092		0					0				
Mar-36			0	75					75						75					0	1167		0					0				
Apr-36		0.28	0	8					8						8					0	1175		0					0				
May-36	0.195	0.28	314	3892	11107	7735	3892	1207	1207	1403	977	0	0	0	1521	0.174	4890	3039	2696	0	0	385	385	165	103	103	32	315	0				
Jun-36	0.291	0.28	612	2388	11107	11543	2388	1585	1585	1403	1458	0	0	0	2196	0.264	4890	4611	2196	0	0	584	584	165	156	156	70	499	0				
Jul-36	0.515	0.28	1005	5810	11107	20429	5810	2681	2681	1403	2581	0	0	0	3686	0.471	4890	8226	3686	0	0	862	862	165	278	278	129	714	0				
Aug-36	0.409	0.50	644	1123	11107	9086	1123	1707	1707	1403	1148	0	0	0	2352	0.354	4890	3462	2352	0	0	680	680	165	117	117	98	661	0	10929	8408		
Sep-36	0.171	0.50	268	0	11107	3799	0	698	698	1403	480	0	0	0	966					0	966	310	310				42	352					
Oct-36		0.50	39	0				67	68					0	107					0	1073	65	65				7	72					
Nov-36			6	1				0	1					0	7					0	1079		0				0	0				
Dec-36			0	0					0						0					0	1080		0					0				
Jan-37			0	0					0						0					0	1080		0					0				
Feb-37			0	4					4						4					0	1084		0					0				
Mar-37			0	0					0						0					0	1084		0					0				
Apr-37		0.28	0	0					0						0					0	1084		0					0				
May-37	0.195	0.28	314	3885	11107	7735	3885	1204	1204	1403	977	0	0	0	1518	0.174	4890	3039	2602	0	0	372	372	165	103	103	32	301	0				
Jun-37	0.291	0.28	600	2387	11107	11543	2387	1583	1583	1403	1458	0	0	0	2183	0.264	4890	4611	2183	0	0	572	572	165	156	156	70	487	0				
Jul-37	0.515	0.28	996	5810	11107	20429	5810	2680	2680	1403	2581	0	0	0	3677	0.471	4890	8226	3677	0	0	856	856	165	278	278	129	707	0				
Aug-37	0.409	0.50	641	1123	11107	9086	1123	1707	1707	1403	1148	0	0	0	2348	0.354	4890	3462	2348	0	0	678	678	165	117	117	98	659	0	10810	8527		
Sep-37	0.171	0.50	268	0	11107	3799	0	698	698	1403	480	0	0	0	966					0	966	309	309				42	351					
Oct-37		0.50	39	0				67	68					0	107					0	1073	65	65				7	72					
Nov-37			6	1				0	1					0	7					0	1079		0				0	0				
Dec-37			0	0					0						0					0	1080		0					0				
Jan-38			0	0					0						0					0	1080		0					0				
Feb-38			0	4					4						4					0	1084		0					0				
Mar-38			0	0					0						6					0	1084		0					0				
Apr-38		0.28	0	0					0						0					0	1084		0					0				
May-38	0.195	0.28	314	3912	11107	7735	3912	1213	1213	1403	977	0	0	0	1527	0.174	4890	3039	2611	0	-0	373	373	165	103	103	32	302	0				
Jun-38	0.291	0.28	689	3092	11107	11543	3092	1887	1887	1403	1458	0	0	0	2496	0.264	4890	4611	2496	0	-0	618	618	165	156	156	70	533	0				
Jul-38	0.515	0.28	1226	7072	11107	20429	7072	3227	3227	1403	2581	0	0	0	4453	0.471	4890	8226	4453	0	-0	998	998	165	278	278	129	850	0				
Aug-38	0.409	0.50	787	1160	11107	9086	1160	2054	2054	1403	1148	0	0	0	2841	0.354	4890	3462	2841	0	-0	815	815	165	117	117	98	796	0	12401	6936		
Sep-38	0.171	0.50	321	0	11107	3799	0	820	820	1403	480	0	0	0	1141					0	1141	374	374				42	417					
Oct-38		0.50	40	0				70	70					0	110					0	1250	79	79				7	86					
Nov-38			6	1				0	1					0	7					0	1257		0				0	0				

Petrolia Normal Storage AF) = 8500 , Dead Storage = 0

(A) Date	(B) NIR Above Petrolia	(C) Eff Above Petrolia	(D) YW Cr Entering Petrolia	(E) FW Cr Above Petrolia	(F) Pre 1950 Acres Abv Petrolia	(G) Pre 1950 Desired Diversion	(H) Pre 1950 Actual Diversion	(I) Return Flow	(J) Stream Flow	(K) Post 1950 Acres Abv Petrolia	(L) Post 1950 Desired Diversion	(M) Available Flow After Pet Rights	(N) Post 1950 Actual Diversion	(O) Return Flow	(P) Petrolia Reservoir Inflow	(Q) NIR Below Petrolia	(R) Pet 1950 Acres Below Res	(S) Pet 1950 Desired Diversion	(T) Pet 1950 Actual Diversion	(U) Spilled Flow	(V) Petrolia Res EOM Storage	(W) Pet. 1950 Return Flow	(X) Stream Flow	(Y) Pre 1950 Damschen Acres	(Z) Damschen Desired Diversion	(AA) Damschen Actual Diversion	(AB) Damschen Return Flow	(AC) Stream Flow	(AD) Pre 1950 Damschen Shortage	(AE) Pet. 1950 Total Ann. Diversion	(AF) Pet. 1950 Total Ann Shortage	(AG) Weibull Plotting Position	(AH) Sorted Pet Ann Yields
Dec-38			0	139					139						139					0	1396		0					0					
Jan-39			0	123					123						123					0	1519		0					0					
Feb-39			0	164					164						164					0	1683		0					0					
Mar-39			0	814					814						814					0	2497		0					0					
Apr-39		0.28	0	91					91						91					0	2587		0					0					
May-39	0.195	0.28	314	4035	11107	7735	4035	1251	1251	1403	977	0	0	0	1565	0.174	4890	3039	3039	0	1114	434	434	165	103	103	32	364	0				
Jun-39	0.291	0.28	689	4214	11107	11543	4214	2182	2182	1403	1458	0	0	0	2871	0.264	4890	4611	3984	0	0	874	874	165	156	156	70	789	0				
Jul-39	0.515	0.28	1252	6247	11107	20429	6247	3226	3226	1403	2581	0	0	0	4478	0.471	4890	8226	4478	0	0	1169	1169	165	278	278	129	1021	0				
Aug-39	0.409	0.50	938	1125	11107	9086	1125	1972	1972	1403	1148	0	0	0	2903	0.354	4890	3462	2903	0	0	887	887	165	117	117	98	868	0	14404	4933		
Sep-39	0.171	0.50	416	0	11107	3799	0	738	738	1403	480	0	0	0	1154					0	1154	379	379				42	422					
Oct-39		0.50	27	0				67	68					0	145					0	1299	80	80				7	87					
Nov-39			6	1				0	1					0	7					0	1306		0				0	0					
Dec-39			0	74					74						74					0	1380		0					0					
Jan-40			0	66					66						66					0	1446		0					0					
Feb-40			0	215					215						215					0	1660		0					0					
Mar-40			0	382					382						382					0	2042		0					0					
Apr-40		0.28	0	3					3						3					0	2045		0					0					
May-40	0.195	0.28	314	3912	11107	7735	3912	1213	1213	1403	977	0	0	0	1527	0.174	4890	3039	3039	0	533	434	434	165	103	103	32	364	0				
Jun-40	0.291	0.28	689	2528	11107	11543	2528	1638	1638	1403	1458	0	0	0	2319	0.264	4890	4611	2852	0	0	712	712	165	156	156	70	627	0				
Jul-40	0.515	0.28	1085	5810	11107	20429	5810	2712	2712	1403	2581	0	0	0	3796	0.471	4890	8226	3796	0	0	958	958	165	278	278	129	810	0				
Aug-40	0.409	0.50	686	1123	11107	9086	1123	1720	1720	1403	1148	0	0	0	2405	0.354	4890	3462	2405	0	0	724	724	165	117	117	98	705	0	12092	7245		
Sep-40	0.171	0.50	276	0	11107	3799	0	698	698	1403	480	0	0	0	974					0	974	318	318				42	360					
Oct-40		0.50	39	0				67	68					0	107					0	1080	67	67				7	74					
Nov-40			6	1				0	1					0	7					0	1087		0				0	0					
Dec-40			0	0					0						0					0	1087		0					0					
Jan-41			0	0					0						0					0	1088		0					0					
Feb-41			0	4					4						4					0	1091		0					0					
Mar-41			0	0					0						0					0	1092		0					0					
Apr-41		0.28	0	0					0						0					0	1092		0					0					
May-41	0.195	0.28	314	3886	11107	7735	3886	1205	1205	1403	977	0	0	0	1519	0.174	4890	3039	2610	0	-0	373	373	165	103	103	32	302	0				
Jun-41	0.291	0.28	634	2652	11107	11543	2652	1665	1665	1403	1458	0	0	0	2299	0.264	4890	4611	2299	0	-0	590	590	165	156	156	70	585	0				
Jul-41	0.515	0.28	1058	6042	11107	20429	6042	2810	2810	1403	2581	0	0	0	3860	0.471	4890	8226	3868	0	-0	894	894	165	278	278	129	746	0				
Aug-41	0.409	0.50	705	1519	11107	9086	1519	1861	1861	1403	1148	0	0	0	2566	0.354	4890	3462	2566	0	-0	722	722	165	117	117	98	703	0	11336	8882		
Sep-41	0.171	0.50	300	0	11107	3799	0	775	775	1403	480	0	0	0	1075					0	1075	331	331				42	373					
Oct-41		0.50	49	1				91	92					0	141					0	1216	71	71				7	78					
Nov-41			6	10				0	10					0	17					0	1232		0				0	0					
Dec-41			0	825					825						825					0	2058		0					0					
Jan-42			0	651					651						651					0	2709		0					0					
Feb-42			0	571					571						571					0	3279		0					0					
Mar-42			0	674					674						674					0	3953		0					0					
Apr-42		0.28	0	3732					3732						3732					0	7685		0					0					
May-42	0.195	0.28	314	6665	11107	7735	6665	2066	2066	1403	977	0	0	0	2380	0.174	4890	3039	3039	0	7027	434	434	165	103	103	32	364	0				
Jun-42	0.291	0.28	2979	10489	11107	11543	10489	4698	4698	1403	1458	1458	1458	452	6671	0.264	4890	4611	4611	707	8380	963	1671	165	156	156	70	1586	0				
Jul-42	0.515	0.28	1252	6801	11107	20429	6801	5004	5004	1403	2581	0	0	316	6573	0.471	4890	8226	8226	0	6727	1768	1768	165	278	278	129	1619	0				
Aug-42	0.409	0.50	959	1739	11107	9086	1739	2799	2799	1403	1148	0	0	136	3894	0.354	4890	3462	3462	0	7159	1340	1340	165	117	117	98	1321	0	19337	0		
Sep-42	0.171	0.58	515	118	11107	3799	118	900	900	1403	480	242	242	48	1221					0	8380	576	576				42	618					
Oct-42		0.58	141	0				121	121					34	296					296	8380	96	392				7	399					
Nov-42			30	1				7	8					15	52					52	8380		52				8	52					
Dec-42			0	439					439						439					439	8380		439					439					
Jan-43			0	499					499						499					499	8380		499					499					
Feb-43			0	1153					1153						1153					1153	8380		1153					1153					

Petrolia Normal Storage (AF) = 8338 . Dead Storage = 0

(A) Date	(B) NIR Above Petrolia	(C) Eff Above Petrolia	(D) FW Cr Entering Petrolia	(E) FW Cr Above Petrolia	(F) Pre 1950 Acres Abv Petrolia	(G) Pre 1950 Desired Diversion	(H) Pre 1950 Actual Diversion	(I) Return Flow	(J) Stream Flow	(K) Post 1950 Acres Abv Petrolia	(L) Post 1950 Desired Diversion	(M) Available Flow After Pet Rights	(N) Post 1950 Actual Diversion	(O) Return Flow	(P) Petrolia Reservoir Inflow	(Q) NIR Below Petrolia	(R) Pet 1950 Acres Below Res	(S) Pet 1950 Desired Diversion	(T) Pet 1950 Actual Diversion	(U) Spilled Flow	(V) Petrolia Res EOM Storage	(W) Pet. 1950 Return Flow	(X) Stream Flow	(Y) Pre 1950 Damschen Acres	(Z) Damschen Desired Diversion	(AA) Damschen Actual Diversion	(AB) Damschen Return Flow	(AC) Stream Flow	(AD) Pre 1950 Damschen Shortage	(AE) Pet. 1950 Total Ann. Diversion	(AF) Pet. 1950 Total Ann Shortage	(AG) Weibull Plotting Position	(AH) Sorted Pet Ann Yields
Mar-43			651	1978					1978						2630					2630	8386		2630					2630					
Apr-43		0.28	237	574					574						811					811	8380		811					811					
May-43	0.195	0.28	887	4295	11107	7735	4295	1331	1331	1403	977	8	0	0	2138	0.174	4890	3039	3039	0	7479	434	434	165	103	103	32	364	0				
Jun-43	0.291	0.28	3260	10642	11107	11543	10642	4231	4231	1403	1458	1458	1458	452	6485	0.264	4890	4611	4611	973	8380	963	1937	165	156	156	70	1851	0				
Jul-43	0.515	0.28	1252	7472	11107	20429	7472	5025	5025	1403	2581	0	0	316	6593	0.471	4890	8226	8226	0	6748	1768	1768	165	278	278	129	1619	0				
Aug-43	0.409	0.50	959	1538	11107	9086	1538	2919	2919	1403	1148	0	0	136	4614	0.354	4890	3462	3462	8	7299	1340	1340	165	117	117	98	1321	0	19337	0		
Sep-43	0.171	0.50	515	0	11107	3799	0	916	916	1403	480	431	431	86	1081					0	8380	576	576				42	618					
Oct-43		8.50	141	0				92	93					60	294					294	8380	96	390				7	397					
Nov-43			30	1				0	1					26	56					56	8380		56				0	56					
Dec-43			0	365					365						365					365	8380		365					365					
Jan-44			0	286					286						286					286	8380		286					286					
Feb-44			0	333					333						333					333	8380		333					333					
Mar-44			0	788					788						788					788	8380		788					788					
Apr-44		0.28	0	71					71						71					71	8380		71					71					
May-44	0.195	0.28	512	3945	11107	7735	3945	1223	1223	1403	977	0	0	0	1735	0.174	4890	3039	3039	0	7077	434	434	165	103	103	32	364	0				
Jun-44	0.291	0.28	1084	5382	11107	11543	5382	2525	2525	1403	1458	0	0	0	3608	0.264	4890	4611	4611	0	6075	963	963	165	156	156	70	878	0				
Jul-44	0.515	0.28	1252	7051	11107	20429	7051	3721	3721	1403	2581	0	0	0	4973	0.471	4890	8226	8226	0	2822	1768	1768	165	278	278	129	1619	0				
Aug-44	0.409	0.50	959	1491	11107	9086	1491	2329	2329	1403	1148	0	0	0	3288	0.354	4890	3462	3462	0	2648	1340	1340	165	117	117	98	1321	0	19337	0		
Sep-44	0.171	0.50	515	0	11107	3799	0	864	864	1403	480	0	0	0	1379					0	4027	576	576				42	618					
Oct-44		0.50	141	0				89	90					0	231					0	4258	96	96				7	103					
Nov-44			30	1				0	1					0	30					0	4288		0				0	0					
Dec-44			0	296					296						296					0	4585		0					0					
Jan-45			0	269					269						269					0	4853		0					0					
Feb-45			0	224					224						224					0	5078		0					0					
Mar-45			0	373					373						373					0	5450		0					0					
Apr-45		0.28	0	2					2						2					0	5453		0					0					
Mar-45	0.195	0.28	314	3922	11107	7735	3922	1216	1216	1403	977	0	0	0	1530	0.174	4890	3039	3039	0	3944	434	434	165	103	103	32	364	0				
Jun-45	0.291	0.28	689	4070	11107	11543	4070	2113	2113	1403	1458	0	0	0	2802	0.264	4890	4611	4611	0	2135	963	963	165	156	156	70	878	0				
Jul-45	0.515	0.28	1252	6022	11107	20429	6022	3115	3115	1403	2581	0	0	0	4357	0.471	4890	8226	6582	0	8	1521	1521	165	278	278	129	1373	0				
Aug-45	0.409	0.50	959	1125	11107	9086	1125	1918	1918	1403	1148	0	0	0	2870	0.354	4890	3462	2876	0	0	1113	1113	165	117	117	98	1094	0	17021	2316		
Sep-45	0.171	0.50	515	0	11107	3799	0	718	718	1403	480	0	0	0	1233					0	1233	464	464				42	506					
Oct-45		0.50	141	0				68	68					0	209					0	1442	79	79				7	86					
Nov-45			30	1				0	1					0	30					0	1472		0				0	0					
Dec-45			0	134					134						134					0	1606		0					0					
Jan-46			0	305					305						305					0	1912		0					0					
Feb-46			0	302					302						302					0	2213		0					0					
Mar-46			0	405					405						405					0	2619		0					0					
Apr-46		0.28	0	4					4						4					0	2623		0					0					
May-46	0.195	0.28	314	3947	11107	7735	3947	1224	1224	1403	977	0	0	0	1538	0.174	4890	3039	3039	0	1122	434	434	165	103	103	32	364	0				
Jun-46	0.291	0.28	689	3167	11107	11543	3167	1838	1838	1403	1458	0	0	0	2527	0.264	4890	4611	3649	0	-0	826	826	165	156	156	70	741	0				
Jul-46	0.515	0.28	1252	5914	11107	20429	5914	2888	2888	1403	2581	0	0	0	4139	0.471	4890	8226	4139	0	-0	1087	1087	165	278	278	129	939	0				
Aug-46	0.409	0.50	959	1123	11107	9086	1123	1802	1802	1403	1148	0	0	0	2762	0.354	4890	3462	2762	8	-0	825	825	165	117	117	98	887	0	13588	5749		
Sep-46	0.171	0.50	515	0	11107	3799	0	707	707	1403	480	0	0	0	1222					0	1222	356	356				42	398					
Oct-46		0.50	141	0				67	68					0	209					0	1431	76	76				7	83					
Nov-46			30	1				0	1					0	30					0	1462		0				0	0					
Dec-46			0	178					178						178					0	1640		0					0					
Jan-47			0	151					151						151					0	1790		0					0					
Feb-47			0	270					270						270					0	2060		0					0					
Mar-47			0	1761					1761						1761					0	3821		0					0					
Apr-47		0.28	0	3835					3835						3835					0	7656		0					0					
May-47	0.195	0.28	314	4129	11107	7735	4129	1280	1280	1403	977	0	0	0	1594	0.174	4890	3039	3039	0	6211	434	434	165	103	103	32	364	0				

Petrolia Normal Storage (AF) = 8380 , Dead Storage = 0

(A) Date	(B) NIR Above Petrolia	(C) Eff Above Petrolia	(D) YW Cr Entering Petrolia	(E) FW Cr Above Petrolia	(F) Pre 1950 Acres Abv Petrolia	(G) Pre 1950 Desired Diversion	(H) Pre 1950 Actual Diversion	(I) Return Flow	(J) Stream Flow	(K) Post 1950 Acres Abv Petrolia	(L) Post 1950 Desired Diversion	(M) Available Flow After Pet Rights	(N) Post 1950 Actual Diversion	(O) Return Flow	(P) Petrolia Reservoir Inflow	(Q) NIR Below Petrolia	(R) Pet 1950 Acres Below Res	(S) Pet 1950 Desired Diversion	(T) Pet 1950 Actual Diversion	(U) Spilled Flow	(V) Petrolia Res EOM Storage	(W) Pet. 1950 Return Flow	(X) Stream Flow	(Y) Pre 1950 Damschen Acres	(Z) Damschen Desired Diversion	(AA) Damschen Actual Diversion	(AB) Damschen Return Flow	(AC) Stream Flow	(AD) Pre 1950 Damschen Shortage	(AE) Pet. 1950 Total Ann. Diversion	(AF) Pet. 1950 Total Ann Shortage	(AG) Weibull Plotting Position	(AH) Sorted Pet Ann Yields
Jun-47	0.291	0.28	689	3641	11107	11543	3841	2087	2087	1403	1458	0	0	0	2776	0.264	4890	4611	4611	0	4376	963	963	165	156	156	70	878	0				
Jul-47	0.515	0.28	1252	5958	11107	20429	5958	3062	3062	1403	2581	0	0	0	4314	0.471	4890	8226	8226	0	464	1768	1768	165	278	278	129	1619	0				
Aug-47	0.409	0.58	959	1131	11107	9086	1131	1875	1875	1403	1148	0	0	0	2834	0.354	4890	3462	3298	0	0	1325	1325	165	117	117	98	1306	0	19173	164		
Sep-47	0.171	0.58	515	0	11107	3799	0	712	712	1403	480	0	0	0	1227					0	1227	566	566				42	608					
Oct-47		0.58	141	0				68	68					0	269					0	1436	91	91				7	98					
Nov-47			30	1				0	1					0	30					0	1467		0				0	0					
Dec-47			0	143					143						143					0	1610		0					0				
Jan-48			0	221					221						221					0	1831		0					0				
Feb-48			0	240					240						240					0	2071		0					0				
Mar-48			0	479					479						479					0	2550		0					0				
Apr-48		0.28	0	58					58						58					0	2608		0					0				
May-48	0.195	0.28	314	4738	11107	7735	4738	1469	1469	1403	977	0	0	0	1783	0.174	4890	3039	3039	0	1352	434	434	165	103	103	32	364	0				
Jun-48	0.291	0.28	2531	10390	11107	11543	10390	4249	4249	1403	1458	0	0	0	6780	0.264	4890	4611	4611	0	3521	963	963	165	156	156	70	878	0				
Jul-48	0.515	0.28	3103	12308	11107	20429	12308	6511	6511	1403	2581	0	0	0	9613	0.471	4890	8226	8226	0	4909	1768	1768	165	278	278	129	1619	0				
Aug-48	0.409	0.58	959	1683	11107	9086	1683	3974	3974	1403	1148	0	0	0	4933	0.354	4890	3462	3462	0	6380	1340	1340	165	117	117	90	1321	0	19337	0		
Sep-48	0.171	0.58	515	0	11107	3799	0	1380	1380	1403	480	0	0	0	1895					0	8275	576	576				42	618					
Oct-48		0.58	141	0				101	101					0	242					138	8380	96	234				7	241					
Nov-48			30	99				0	99					0	129					129	8380		129				0	129					
Dec-48			0	185					185						185					185	8380		185					185				
Jan-49			0	140					140						140					140	8380		140					140				
Feb-49			0	580					580						580					580	8380		580					580				
Mar-49			1028	3394					3394						4421					4421	8380		4421					4421				
Apr-49		0.28	168	386					386						545					545	8380		545					545				
May-49	0.195	0.28	796	4270	11107	7735	4270	1324	1324	1403	977	0	0	0	2120	0.174	4890	3039	3039	0	7461	434	434	165	103	103	32	364	0				
Jun-49	0.291	0.28	986	4953	11107	11543	4953	2462	2462	1403	1458	0	0	0	3368	0.264	4890	4611	4611	0	6219	963	963	165	156	156	70	878	0				
Jul-49	0.515	0.28	1468	8326	11107	20429	8326	4053	4053	1403	2581	0	0	0	5521	0.471	4890	8226	8226	0	3515	1768	1768	165	278	278	129	1619	0				
Aug-49	0.409	0.58	959	1353	11107	9086	1353	2538	2538	1403	1148	0	0	0	3497	0.354	4890	3462	3462	0	3550	1340	1340	165	117	117	90	1321	0	19337	0		
Sep-49	0.171	0.58	515	0	11107	3799	0	964	964	1403	480	0	0	0	1479					0	5029	576	576				42	618					
Oct-49		0.58	141	0				81	82					0	223					0	5251	96	96				7	103					
Nov-49			30	0				0	0					0	30					0	5282		0				0	0					
Dec-49			0	0					0						0					0	5282		0					0				
Jan-50			0	0					0						0					0	5282		0					0				
Feb-50			0	23					23						23					0	5305		0					0				
Mar-50			0	847					847						847					0	6152		0					0				
Apr-50		0.28	0	562					562						562					0	6714		0					0				
May-50	0.195	0.28	454	4252	11107	7735	4252	1318	1318	1403	977	0	0	0	1772	0.174	4890	3039	3039	0	5446	434	434	165	103	103	32	364	0				
Jun-50	0.291	0.28	1024	5237	11107	11543	5237	2546	2546	1403	1458	0	0	0	3570	0.264	4890	4611	4611	0	4406	963	963	165	156	156	70	878	0				
Jul-50	0.515	0.28	1626	8786	11107	20429	8786	4231	4231	1403	2581	0	0	0	5856	0.471	4890	8226	8226	0	2036	1768	1768	165	278	278	129	1619	0				
Aug-50	0.409	0.58	959	1378	11107	9086	1378	2652	2652	1403	1148	0	0	0	3611	0.354	4890	3462	3462	0	2185	1340	1340	165	117	117	98	1321	0	19337	0		
Sep-50	0.171	0.58	515	0	11107	3799	0	1003	1003	1403	480	0	0	0	1518					0	3703	576	576				42	618					
Oct-50		0.58	141	0				83	83					0	224					0	3927	96	96				7	103					
Nov-50			30	0				0	0					0	30					0	3957		0				0	0					
Dec-50			0	103					103						103					0	4061		0					0				
			0	126																													
			0	212																													
			0	1331																													
			283	1129																													

Total Damschen Shortage (af)= 0
Firm Petrolia Yield (af) = 10810
80% Petrolia Yield (af) = 12129

Petrolia Normal Storage (AF) = 9470 Dead Storage = 0

(A) Date	(B) NIR Above Petrolia	(C) Eff Above Petrolia	(D) YW Cr Entering Petrolia	(E) FW Cr Above Petrolia	(F) Pre 1950 Acres Abv Petrolia	(G) Pre 1950 Desired Diversion	(H) Pre 1950 Actual Diversion	(I) Return Flow	(J) Stream Flow	(K) Post 1950 Acres Abv Petrolia	(L) Post 1950 Desired Diversion	(M) Available Flow After Pet Rights	(N) Post 1950 Actual Diversion	(O) Return Flow	(P) Petrolia Reservoir Inflow	(Q) NIR Below Petrolia	(R) Pet 1950 Acres Below Res	(S) Pet 1950 Desired Diversion	(T) Pet 1950 Actual Diversion	(U) Spilled Flow	(V) Petrolia Res EOM Storage	(W) Pet. 1950 Return Flow	(X) Stream Flow	(Y) Pre 1950 Damschen Acres	(Z) Damschen Desired Diversion	(AA) Damschen Actual Diversion	(AB) Damschen Return Flow	(AC) Stream Flow	(AD) Pre 1950 Damschen Shortage	(AE) Pet. 1950 Total Ann. Diversion	(AF) Pet. 1950 Total Ann Shortage	(AG) Weibull Plotting Position	(AH) Sorted Pet Ann Yields
																					9470												0.033	19337
Jan-22			334	806					806						1140					1140	9470		1140					1140				0.067	19337
Feb-22			232	568					568						791					791	9470		791					791				0.100	19337
Mar-22			2474	5981					5981						8455					8455	9470		8455					8455				0.133	19337
Apr-22		0.28	1393	3367					3367						4760					4760	9470		4760					4760				0.167	19337
May-22	0.195	0.28	2389	8119	11107	7735	7735	2398	2782	1403	977	977	977	303	4497	0.174	4890	3039	3039	1458	9470	434	1892	165	103	103	32	1822	0			0.200	19337
Jun-22	0.291	0.28	5853	16427	11107	11543	11543	5257	10141	1403	1458	1458	1458	664	15600	0.264	4890	4611	4611	10389	9470	963	11352	165	156	156	70	11267	0			0.233	19337
Jul-22	0.515	0.28	1411	8188	11107	20429	8188	5763	5763	1403	2581	0	0	407	7581	0.471	4890	8226	8226	0	8825	1768	1768	165	278	278	129	1619	0			0.267	19337
Aug-22	0.409	0.58	959	1214	11107	9886	1214	3093	3093	1403	1148	102	102	156	4107	0.354	4890	3462	3462	0	9470	1340	1340	165	117	117	98	1321	0	19337	0	0.300	19337
Sep-22	0.171	0.58	515	0	11107	3799	0	932	932	1403	480	480	480	110	1077					1077	9470	576	1653				42	1695				0.333	19337
Oct-22		0.58	141	0				73	73					73	288					288	9470	96	383				7	390				0.367	19337
Nov-22			30	605				0	605					29	664					664	9470		664				0	664				0.400	19337
Dec-22			0	827					827						827					827	9470		827					827				0.433	19337
Jan-23			0	941					941						941					941	9470		941					941				0.467	19337
Feb-23			274	672					672						946					946	9470		946					946				0.500	19337
Mar-23			500	1210					1210						1710					1710	9470		1710					1710				0.533	19337
Apr-23		0.28	879	2123					2123						3002					3002	9470		3002					3002				0.567	19337
May-23	0.195	0.28	1218	5298	11107	7735	5298	1648	1648	1403	977	0	0	0	2858	0.174	4890	3039	3039	0	9290	434	434	165	103	103	32	364	0			0.600	19337
Jun-23	0.291	0.28	8489	23.81	11107	11543	11543	4726	16464	1403	1458	1458	1458	452	23947	0.264	4890	4611	4611	19156	9470	963	20120	165	156	156	70	20034	0			0.633	19173
Jul-23	0.515	0.28	9660	28126	11107	20429	20429	9330	17027	1403	2581	2581	2581	1116	25223	0.471	4890	8226	8226	16997	9470	1768	18764	165	278	278	129	18616	0			0.667	18111
Aug-23	0.409	0.58	2305	6346	11107	9886	6346	6776	6776	1403	1148	1148	1148	925	8859	0.354	4890	3462	3462	5397	9470	1340	6737	165	117	117	98	6718	0	19337	0	0.700	14404
Sep-23	0.171	0.58	1087	2568	11107	3799	2568	3302	3302	1403	480	480	480	497	4406					4406	9470	576	4982				42	5024				0.733	13588
Oct-23		0.58	1461	2913				740	3653					136	5190					5190	9470	96	5286				7	5293				0.767	12795
Nov-23			1131	2635				154	2789					29	3949					3949	9470		3949				0	3949				0.800	12401
Dec-23			862	2083					2083						2945					2945	9470		2945					2945				0.833	12092
Jan-24			695	1680					1680						2375					2375	9470		2375					2375				0.867	11336
Feb-24			556	1344					1344						1900					1900	9470		1900					1900				0.900	11224
Mar-24			1026	2480					2480						3506					3506	9470		3506					3506				0.933	10929
Apr-24		0.28	3364	8131					8131						11495					11495	9470		11495					11495				0.967	10810
May-24	0.195	0.28	3987	11983	11107	7735	7735	2398	6646	1403	977	977	977	303	9959	0.174	4890	3039	3039	6920	9470	434	7355	165	103	103	32	7284	0				
Jun-24	0.291	0.28	4347	13269	11107	11543	11543	5257	6982	1403	1458	1458	1458	664	10535	0.264	4890	4611	4611	5924	9470	963	6887	165	156	156	70	6802	0				
Jul-24	0.515	0.28	2365	10493	11107	20429	10493	6477	6477	1403	2581	1483	1483	867	8226	0.471	4890	8226	8226	0	9470	1768	1768	165	278	278	129	1619	0				
Aug-24	0.409	0.58	959	2314	11107	9886	2314	3813	3813	1403	1148	1148	1148	687	4312	0.354	4890	3462	3462	850	9470	1340	2190	165	117	117	98	2171	0	19337	0		
Sep-24	0.171	0.58	515	522	11107	3799	522	1404	1404	1403	480	480	480	395	1834					1834	9470	576	2410				42	2452					
Oct-24		0.58	141	312				212	524					136	801					801	9470	96	897				7	904					
Nov-24			194	1022				31	1053					29	1276					1276	9470		1276				0	1276					
Dec-24			512	1236					1236						1748					1748	9470		1748					1748					
Jan-25			428	1035					1035						1463					1463	9470		1463					1463					
Feb-25			500	1210					1210						1710					1710	9470		1710					1710					
Mar-25			1368	3306					3306						4674					4674	9470		4674					4674					
Apr-25		0.28	973	2352					2352						3325					3325	9470		3325					3325					
May-25	0.195	0.28	818	4323	11107	7735	4323	1340	1340	1403	977	0	0	0	2158	0.174	4890	3039	3039	0	8589	434	434	165	103	103	32	364	0				
Jun-25	0.291	0.28	1133	5500	11107	11543	5500	2643	2643	1403	1458	0	0	0	3776	0.264	4890	4611	4611	0	7755	963	963	165	156	156	70	878	0				
Jul-25	0.515	0.28	1252	7052	11107	20429	7682	3791	3791	1403	2581	0	0	0	5043	0.471	4890	8226	8226	0	4572	1768	1768	165	278	278	129	1619	0				
Aug-25	0.409	0.58	959	1139	11107	9886	1139	2276	2276	1403	1148	0	0	0	3235	0.354	4890	3462	3462	0	4345	1340	1340	165	117	117	98	1321	0	19337	0		
Sep-25	0.171	0.58	515	0	11107	3799	0	818	818	1403	480	0	0	0	1333					0	5679	576	576				42	618					
Oct-25		0.58	141	0				68	69					0	210					0	5888	96	96				7	103					
Nov-25			30	456				0	456					0	486					0	6374		0				0	0					
Dec-25			0	531					531						531					0	6905		0					0					
Jan-26			0	331					331						331					0	7236		0					0					
Feb-26			0	298					298						298					0	7534		0					0					

Petrolia Normal Storage (AF) = 9470 , Dead Storage = 0

(A) Date	(B) NIR Above Petrolia	(C) Eff Above Petrolia	(D) YW Cr Entering Petrolia	(E) FW Cr Above Petrolia	(F) Pre 1950 Acres Abv Petrolia	(G) Pre 1950 Desired Diversion	(H) Pre 1950 Actual Diversion	(I) Return Flow	(J) Stream Flow	(K) Post 1950 Acres Abv Petrolia	(L) Post 1950 Desired Diversion	(M) Available Flow After Pet Rights	(N) Post 1950 Actual Diversion	(O) Return Flow	(P) Petrolia Reservoir Inflow	(Q) NIR Below Petrolia	(R) Pet 1950 Acres Below Res	(S) Pet 1950 Desired Diversion	(T) Pet 1950 Actual Diversion	(U) Spilled Flow	(V) Petrolia Res EOM Storage	(W) Pet. 1950 Return Flow	(X) Stream Flow	(Y) Pre 1950 Danscheo Acres	(Z) Danscheo Desired Diversion	(AA) Danscheo Actual Diversion	(AB) Danscheo Return Flow	(AC) Stream Flow	(AD) Pre 1950 Danscheo Shortage	(AE) Pet. 1950 Total Aon. Diversion	(AF) Pet. 1950 Total Aon Shortage	(AG) Weibull Plotting Positino	(AH) Sorted Pet Ano Yields
Mar-26			0	331					331						331					0	7865		0					0					
Apr-26		0.28	0	444					444						444					0	8308		0					0					
May-26	0.195	0.28	314	3471	11107	7735	3471	1076	1076	1403	977	0	0	0	1398	0.174	4890	3039	3039	0	6868	434	434	165	103	103	32	364	0				
Jun-26	0.291	0.28	689	4852	11107	11543	4862	2013	2013	1403	1458	0	0	0	2701	0.264	4890	4611	4611	0	4750	963	963	165	156	156	70	878	0				
Jul-26	0.515	0.28	1252	7858	11107	20429	7898	3405	3405	1403	2581	0	0	0	4657	0.471	4890	8226	8226	0	1181	1768	1768	165	278	278	129	1619	0				
Aug-26	0.409	0.50	959	1139	11107	9886	1139	2146	2146	1403	1148	0	0	0	3105	0.354	4890	3462	3462	0	825	1348	1348	165	117	117	98	1321	0	19337	0		
Sep-26	0.171	0.50	515	0	11107	3799	0	820	820	1403	480	0	0	0	1335					0	2159	576	576				42	618					
Oct-26		0.50	141	588				68	656					0	797					0	2956	96	96				7	103					
Nov-26			30	0				0	0					0	30					0	2986		0				0	0					
Dec-26			0	289					289						289					0	3275		0					0					
Jan-27			0	202					202						202					0	3477		0					0					
Feb-27			0	181					181						181					0	3658		0					0					
Mar-27			662	3360					3360						4022					0	7681		0					0					
Apr-27		0.28	681	1451					1451						2052					263	9470		263					263					
May-27	0.195	0.28	810	21929	11107	7735	7735	2398	16591	1403	977	977	977	303	20019	0.174	4890	3039	3039	20980	9470	434	21415	165	103	103	32	21344	0				
Jun-27	0.291	0.28	7433	20728	11107	11543	11543	5257	14441	1403	1458	1458	1458	664	21088	0.264	4890	4611	4611	16469	9470	963	17432	165	156	156	70	17347	0				
Jul-27	0.515	0.28	2270	10264	11107	20429	10284	6486	6486	1403	2581	1244	1244	793	8226	0.471	4890	8226	8226	0	9470	1768	1768	165	278	278	129	1619	0				
Aug-27	0.409	0.50	959	1925	11107	9886	1925	3580	3680	1403	1148	1148	1148	635	4133	0.354	4890	3462	3462	671	9470	1348	2011	165	117	117	98	1992	0	19337	0		
Sep-27	0.171	0.50	515	855	11107	3799	855	1395	1395	1403	480	480	480	372	1803					1803	9470	576	2379				42	2421					
Oct-27		0.50	141	688				235	924					136	1201					1201	9470	96	1296				7	1303					
Nov-27			509	1465				51	1517					29	2055					2055	9470		2055				0	2055					
Dec-27			584	1411					1411						1995					1995	9470		1995					1995					
Jan-28			500	1210					1210						1710					1710	9470		1710					1710					
Feb-28			417	1008					1008						1425					1425	9470		1425					1425					
Mar-28			890	2150					2150						3040					3040	9470		3040					3040					
Apr-28		0.28	940	2271					2271						3211					3211	9470		3211					3211					
May-28	0.195	0.28	1071	4934	11107	7735	4934	1530	1530	1403	977	0	0	0	2601	0.174	4890	3039	3039	0	9832	434	434	165	103	103	32	364	0				
Jun-28	0.291	0.28	689	4242	11107	11543	4242	2386	2386	1403	1458	0	0	0	3075	0.264	4890	4611	4611	0	7496	963	963	165	156	156	70	878	0				
Jul-28	0.515	0.28	1743	9848	11107	20429	9848	4184	4184	1403	2581	0	0	0	5928	0.471	4890	8226	8226	0	5198	1768	1768	165	278	278	129	1619	0				
Aug-28	0.409	0.50	959	1298	11107	9886	1298	2618	2618	1403	1148	0	0	0	3577	0.354	4890	3462	3462	0	5313	1348	1348	165	117	117	98	1321	0	19337	0		
Sep-28	0.171	0.50	515	86	11107	3799	86	1040	1040	1403	480	0	0	0	1555					0	6868	576	576				42	618					
Oct-28		0.50	141	0				98	98					0	231					0	7099	96	96				7	103					
Nov-28			30	343				5	348					0	378					0	7478		0				0	0					
Dec-28			0	470					470						470					0	7948		0					0					
Jan-29			0	413					413						413					0	8361		0					0					
Feb-29			0	373					373						373					0	8734		0					0					
Mar-29			1661	4704					4704						6365					5629	9470		5629					5629					
Apr-29		0.28	603	1458					1458						2061					2061	9470		2061					2061					
May-29	0.195	0.28	1513	6883	11107	7735	6883	1861	1861	1403	977	486	486	151	3039	0.174	4890	3039	3039	0	9470	434	434	165	103	103	32	364	0				
Jun-29	0.291	0.28	1953	7483	11107	11543	7483	3622	3622	1403	1458	1458	1458	557	4675	0.264	4890	4611	4611	64	9470	963	1027	165	156	156	70	942	0				
Jul-29	0.515	0.28	1252	7398	11107	20429	7398	4475	4475	1403	2581	0	0	362	6889	0.471	4890	8226	8226	0	7333	1768	1768	165	278	278	129	1619	0				
Aug-29	0.409	0.50	959	1139	11107	9886	1139	2529	2529	1403	1148	0	0	136	3624	0.354	4890	3462	3462	0	7495	1348	1348	165	117	117	98	1321	0	19337	0		
Sep-29	0.171	0.50	515	0	11107	3799	0	848	848	1403	480	0	0	0	1363					0	8858	576	576				42	618					
Oct-29		0.50	141	0				68	69					0	210					0	9868	96	96				7	103					
Nov-29			30	181				0	181					0	211					0	9278		0				0	0					
Dec-29			0	381					381						381					189	9470		189					189					
Jan-30			0	374					374						374					374	9470		374					374					
Feb-30			0	687					687						687					687	9470		687					687					
Mar-30			486	2271					2271						2757					2757	9470		2757					2757					
Apr-30		0.28	884	2137					2137						3021					3021	9470		3021					3021					
May-30	0.195	0.28	1172	5178	11107	7735	5178	1685	1685	1403	977	0	0	0	2777	0.174	4890	3039	3039	0	9289	434	434	165	103	103	32	364	0				

Petrolia Normal Storage (AF) = 9470 , Dead Storage = 0

(A) Date	(B) NIR Above Petrolia	(C) Eff Above Petrolia	(D) YW Cr Entering Petrolia	(E) FW Cr Above Petrolia	(F) Pre 1950 Acres Abv Petrolia	(G) Pre 1950 Desired Diversion	(H) Pre 1950 Actual Diversion	(I) Return Flow	(J) Stream Flow	(K) Post 1950 Acres Abv Petrolia	(L) Post 1950 Desired Diversion	(M) Available Flow After Pet Rights	(N) Post 1950 Actual Diversion	(O) Return Flow	(P) Petrolia Reservoir Inflow	(Q) NIR Below Petrolia	(R) Pet 1950 Acres Below Res	(S) Pet 1950 Desired Diversion	(T) Pet 1950 Actual Diversion	(U) Spilled Flow	(V) Petrolia Res EOM Storage	(W) Pet. 1950 Return Flow	(X) Stream Flow	(Y) Pre 1950 Damschen Acres	(Z) Damschen Desired Diversion	(AA) Damschen Actual Diversion	(AB) Damschen Return Flow	(AC) Stream Flow	(AD) Pre 1950 Damschen Shortage	(AE) Pet. 1950 Total Ann. Diversion	(AF) Pet. 1950 Total Ann Shortage	(AG) Weibull Plotting Position	(AH) Sorted Pet Ann Yields
Jun-30	0.291	0.28	810	4721	11107	11543	4721	2587	2587	1403	1458	0	0	0	3397	0.264	4890	4611	4611	0	7995	963	963	165	156	156	70	878	0				
Jul-30	0.515	0.28	1470	8330	11107	20429	8330	4088	4088	1403	2581	0	0	0	5558	0.471	4890	8226	8226	0	5328	1768	1768	165	278	278	129	1619	0				
Aug-30	0.409	0.50	959	1303	11107	9086	1303	2507	2507	1403	1148	0	0	0	3467	0.354	4890	3462	3462	0	5335	1340	1340	165	117	117	98	1321	0	19337	0		
Sep-30	0.171	0.50	515	21	11107	3799	21	961	961	1403	480	0	0	0	1476					0	6809	576	576				42	618					
Oct-30		0.50	141	0				81	81					0	222					0	7031	96	96				7	103					
Nov-30			30	0				1	1					0	31					0	7063		0				0	0					
Dec-30			0	241					241						241					0	7304		0					0				
Jan-31			0	687					687						687					0	7992		0					0				
Feb-31			0	653					653						653					0	8645		0					0				
Mar-31			0	359					359						359					0	9004		0					0				
Apr-31		0.28	0	41					41						41					0	9045		0					0				
May-31	0.195	0.28	538	3949	11107	7735	3949	1224	1224	1403	977	6	0	0	1762	0.174	4890	3039	3039	0	7769	434	434	165	103	103	32	364	0				
Jun-31	0.291	0.28	781	4651	11107	11543	4651	2299	2299	1403	1458	0	0	0	3080	0.264	4890	4611	4611	0	6238	963	963	165	156	156	70	878	0				
Jul-31	0.515	0.28	1351	8043	11107	20429	8043	3870	3870	1403	2581	0	0	0	5221	0.471	4890	8226	8226	0	3233	1768	1768	165	278	278	129	1619	0				
Aug-31	0.409	0.50	959	1303	11107	9086	1303	2439	2439	1403	1148	0	0	0	3398	0.354	4890	3462	3462	0	3169	1340	1340	165	117	117	98	1321	0	19337	0		
Sep-31	0.171	0.50	515	0	11107	3799	0	931	931	1403	480	0	0	0	1446					0	4615	576	576				42	618					
Oct-31		0.50	141	0				78	79					0	220					0	4834	96	96				7	103					
Nov-31			30	0				0	0					0	30					0	4864		0				0	0				
Dec-31			0	0					0						0					0	4865		0					0				
Jan-32			0	0					0						0					0	4865		0					0				
Feb-32			0	4					4						4					0	4869		0					0				
Mar-32			0	0					0						0					0	4869		0					0				
Apr-32		0.28	0	0					0						0					0	4869		0					0				
May-32	0.195	0.28	314	4950	11107	7735	4950	1534	1534	1403	977	0	0	0	1849	0.174	4890	3039	3039	0	3679	434	434	165	103	103	32	364	0				
Jun-32	0.291	0.28	4948	14999	11107	11543	11543	4653	8189	1403	1458	1458	1458	452	12850	0.264	4890	4611	4611	1649	9478	963	2612	165	156	156	70	2527	0				
Jul-32	0.515	0.28	2939	11914	11107	20429	11914	6658	6658	1403	2581	2447	2447	1075	8226	0.471	4890	8226	8226	0	9478	1768	1768	165	278	278	129	1619	0				
Aug-32	0.409	0.50	959	1457	11107	9086	1457	3958	3958	1403	1148	1148	1148	896	4658	0.354	4890	3462	3462	1196	9478	1340	2536	165	117	117	98	2517	0	19337	0		
Sep-32	0.171	0.50	515	0	11107	3799	0	1312	1312	1403	480	480	480	484	1831					1831	9478	576	2408				42	2450					
Oct-32		0.50	141	0				87	88					136	365					365	9478	96	461				7	468					
Nov-32			30	1				0	1					29	59					59	9478		59				0	59					
Dec-32			0	0					0						0					0	9478		0					0				
Jan-33			0	0					0						0					0	9478		0					0				
Feb-33			0	4					4						4					4	9478		4					4				
Mar-33			0	0					0						0					0	9478		0					0				
Apr-33		0.28	0	0					0						0					0	9478		0					0				
May-33	0.195	0.28	314	3889	11107	7735	3889	1206	1206	1403	977	0	0	0	1520	0.174	4890	3039	3039	0	7951	434	434	165	103	103	32	364	0				
Jun-33	0.291	0.28	689	2560	11107	11543	2560	1637	1637	1403	1458	0	0	0	2326	0.264	4890	4611	4611	0	5667	963	963	165	156	156	70	878	0				
Jul-33	0.515	0.28	1252	5874	11107	20429	5874	2738	2738	1403	2581	0	0	0	3990	0.471	4890	8226	8226	0	1431	1768	1768	165	278	278	129	1619	0				
Aug-33	0.409	0.50	959	1123	11107	9086	1123	1737	1737	1403	1148	0	0	0	2697	0.354	4890	3462	3462	0	665	1340	1340	165	117	117	98	1321	0	19337	0		
Sep-33	0.171	0.50	515	0	11107	3799	0	703	703	1403	480	0	0	0	1218					0	1884	576	576				42	618					
Oct-33		0.50	141	0				67	68					0	209					0	2093	96	96				7	103					
Nov-33			30	1				0	1					0	30					0	2123		0				0	0				
Dec-33			0	0					0						0					0	2123		0					0				
Jan-34			0	0					0						0					0	2124		0					0				
Feb-34			0	4					4						4					0	2127		0					0				
Mar-34			0	270					270						270					0	2397		0					0				
Apr-34		0.28	0	0					0						0					0	2398		0					0				
May-34	0.195	0.28	314	3885	11107	7735	3885	1204	1204	1403	977	0	0	0	1518	0.174	4890	3039	3039	0	877	434	434	165	103	103	32	364	0				
Jun-34	0.291	0.28	689	2404	11107	11543	2404	1588	1588	1403	1458	0	0	0	2277	0.264	4890	4611	3154	0	-0	755	755	165	156	156	70	670	0				
Jul-34	0.515	0.28	1252	5810	11107	20429	5810	2684	2684	1403	2581	0	0	0	3936	0.471	4890	8226	3936	0	-0	1009	1009	165	278	278	129	860	0				
Aug-34	0.409	0.50	956	1123	11107	9086	1123	1709	1709	1403	1148	0	0	0	2665	0.354	4890	3462	2665	0	-0	775	775	165	117	117	98	756	0	12795	6543		

Petrolia Normal Storage (AF) = 9470 , Dead Storage = 0

(A) Date	(B) NIR Above Petrolia	(C) Eff Above Petrolia	(D) YW Cr Entering Petrolia	(E) FW Cr Above Petrolia	(F) Pre 1950 Acres Abv Petrolia	(G) Pre 1950 Desired Diversion	(H) Pre 1950 Actual Diversion	(I) Return Flow	(J) Stream Flow	(K) Post 1950 Acres Abv Petrolia	(L) Post 1950 Desired Diversion	(M) Available Flow After Pet Rights	(N) Post 1950 Actual Diversion	(O) Return Flow	(P) Petrolia Reservoir Inflow	(Q) NIR Below Petrolia	(R) Pet 1950 Acres Below Res	(S) Pet 1950 Desired Diversion	(T) Pet 1950 Actual Diversion	(U) Spilled Flow	(V) Petrolia Res EOM Storage	(W) Pet. 1950 Return Flow	(X) Stream Flow	(Y) Pre 1950 Damschen Acres	(Z) Damschen Desired Diversion	(AA) Damschen Actual Diversion	(AB) Damschen Return Flow	(AC) Stream Flow	(AD) Pre 1950 Damschen Shortage	(AE) Pet. 1950 Total Ann. Diversion	(AF) Pet. 1950 Total Ann Shortage	(AG) Weibull Plotting Position	(AH) Sorted Pet Ann Yields
Sep-34	0.171	0.50	434	0	11107	3799	0	698	698	1403	480	0	0	0	1131					0	1131	341	341				42	383					
Oct-34		0.50	85	0				67	68					0	153					0	1284	74	74				7	81					
Nov-34			6	1				0	1					0	7					0	1291		0				0	0					
Dec-34			0	0					0						0					0	1291		0					0				
Jan-35			0	0					0						0					0	1291		0					0				
Feb-35			0	4					4						4					0	1295		0					0				
Mar-35			0	0					0						0					0	1295		0					0				
Apr-35		0.28	0	0					0						0					0	1295		0					0				
May-35	0.195	0.28	314	3889	11107	7735	3889	1206	1206	1403	977	0	0	0	1520	0.174	4890	3039	2815	0	-0	402	402	165	103	103	32	332	0				
Jun-35	0.291	0.28	623	2560	11107	11543	2560	1637	1637	1403	1458	0	0	0	2260	0.264	4890	4611	2260	0	-0	605	605	165	156	156	70	520	0				
Jul-35	0.515	0.28	1021	5874	11107	20429	5874	2738	2738	1403	2581	0	0	0	3759	0.471	4890	8226	3759	0	-0	884	884	165	278	278	129	736	0				
Aug-35	0.489	0.50	653	1123	11107	9086	1123	1737	1737	1403	1148	0	0	0	2391	0.354	4890	3462	2391	0	-0	694	694	165	117	117	98	675	0	11224	8113		
Sep-35	0.171	0.50	271	0	11107	3799	0	703	703	1403	480	0	0	0	974					0	974	316	316				42	358					
Oct-35		0.50	39	0				67	68					0	107					0	1081	66	66				7	73					
Nov-35			6	1				0	1					0	7					0	1088		0				0	0				
Dec-35			0	0					0						0					0	1088		0					0				
Jan-36			0	0					0						0					0	1088		0					0				
Feb-36			0	4					4						4					0	1092		0					0				
Mar-36			0	75					75						75					0	1167		0					0				
Apr-36		0.28	0	8					8						8					0	1175		0					0				
May-36	0.195	0.28	314	3892	11107	7735	3892	1207	1207	1403	977	0	0	0	1521	0.174	4890	3039	2696	0	0	385	385	165	103	103	32	315	0				
Jun-36	0.291	0.28	612	2388	11107	11543	2388	1585	1585	1403	1458	0	0	0	2196	0.264	4890	4611	2196	0	0	584	584	165	156	156	70	499	0				
Jul-36	0.515	0.28	1005	5810	11107	20429	5810	2681	2681	1403	2581	0	0	0	3686	0.471	4890	8226	3686	0	0	862	862	165	278	278	129	714	0				
Aug-36	0.489	0.50	644	1123	11107	9086	1123	1707	1707	1403	1148	0	0	0	2352	0.354	4890	3462	2352	0	0	680	680	165	117	117	98	661	0	10929	8408		
Sep-36	0.171	0.50	268	0	11107	3799	0	698	698	1403	480	0	0	0	966					0	966	310	310				42	352					
Oct-36		0.50	39	0				67	68					0	107					0	1073	65	65				7	72					
Nov-36			6	1				0	1					0	7					0	1079		0				0	0				
Dec-36			0	0					0						0					0	1080		0					0				
Jan-37			0	0					0						0					0	1080		0					0				
Feb-37			0	4					4						4					0	1084		0					0				
Mar-37			0	0					0						0					0	1084		0					0				
Apr-37		0.28	0	0					0						0					0	1084		0					0				
May-37	0.195	0.28	314	3885	11107	7735	3885	1204	1204	1403	977	0	0	0	1518	0.174	4890	3039	2602	0	0	372	372	165	103	103	32	301	0				
Jun-37	0.291	0.28	600	2387	11107	11543	2387	1583	1583	1403	1458	0	0	0	2183	0.264	4890	4611	2183	0	0	572	572	165	156	156	70	487	0				
Jul-37	0.515	0.28	996	5810	11107	20429	5810	2680	2680	1403	2581	0	0	0	3677	0.471	4890	8226	3677	0	0	856	856	165	278	278	129	707	0				
Aug-37	0.489	0.50	641	1123	11107	9086	1123	1707	1707	1403	1148	0	0	0	2348	0.354	4890	3462	2348	0	0	678	678	165	117	117	98	659	0	10810	8527		
Sep-37	0.171	0.50	268	0	11107	3799	0	698	698	1403	480	0	0	0	966					0	966	309	309				42	351					
Oct-37		0.50	39	0				67	68					0	107					0	1073	65	65				7	72					
Nov 37			6	1				0	1					0	7					0	1079		0				0	0				
Dec-37			0	0					0						0					0	1080		0					0				
Jan-38			0	0					0						0					0	1080		0					0				
Feb-38			0	4					4						4					0	1084		0					0				
Mar-38			0	0					0						0					0	1084		0					0				
Apr-38		0.28	0	0					0						0					0	1084		0					0				
May-38	0.195	0.28	314	3912	11107	7735	3912	1213	1213	1403	977	0	0	0	1527	0.174	4890	3039	2611	0	-0	373	373	165	103	103	32	302	0				
Jun-38	0.291	0.28	689	3892	11107	11543	3892	1807	1807	1403	1458	0	0	0	2496	0.264	4890	4611	2496	0	-0	618	618	165	156	156	70	533	0				
Jul-38	0.515	0.28	1226	7072	11107	20429	7072	3227	3227	1403	2581	0	0	0	4453	0.471	4890	8226	4453	0	-0	998	998	165	278	278	129	850	0				
Aug-38	0.489	0.50	787	1160	11107	9086	1160	2054	2054	1403	1148	0	0	0	2841	0.354	4890	3462	2841	0	-0	815	815	165	117	117	98	796	0	12401	6936		
Sep-38	0.171	0.50	321	0	11107	3799	0	826	820	1403	480	0	0	0	1141					0	1141	374	374				42	417					
Oct-38		0.50	40	0				70	70					0	110					0	1256	79	79				7	86					
Nov-38			6	1				0	1					0	7					0	1257		0				0	0				

Petrolia Normal Storage (AF) = 9470 , Dead Storage = 0

(A) Date	(B) NIR Above Petrolia	(C) Eff Above Petrolia	(D) YW Cr Entering Petrolia	(E) FW Cr Above Petrolia	(F) Pre 1950 Acres Abv Petrolia	(G) Pre 1950 Desired Diversion	(H) Pre 1950 Actual Diversion	(I) Return Flow	(J) Stream Flow	(K) Post 1950 Acres Abv Petrolia	(L) Post 1950 Desired Diversion	(M) Available Flow After Pet Rights	(N) Post 1950 Actual Diversion	(O) Return Flow	(P) Petrolia Reservoir Inflow	(Q) NIR Below Petrolia	(R) Pet 1950 Acres Below Res	(S) Pet 1950 Desired Diversion	(T) Pet 1950 Actual Diversion	(U) Spilled Flow	(V) Petrolia Res EOM Storage	(W) Pet. 1950 Return Flow	(X) Stream Flow	(Y) Pre 1950 Damschen Acres	(Z) Damschen Desired Diversion	(AA) Damschen Actual Diversion	(AB) Damschen Return Flow	(AC) Stream Flow	(AD) Pre 1950 Damschen Shortage	(AE) Pet. 1950 Total Ann. Diversion	(AF) Pet. 1950 Total Ann. Shortage	(AG) Weibull Plotting Position	(AH) Sorted Pet Ann Yields
Dec-38			0	139					139						139					0	1396		0					0					
Jan-39			0	123					123						123					0	1519		0					0					
Feb-39			0	164					164						164					0	1683		0					0					
Mar-39			0	814					814						814					0	2497		0					0					
Apr-39		0.28	0	91					91						91					0	2587		0					0					
May-39	0.195	0.28	314	4035	11107	7735	4035	1251	1251	1403	977	0	0	0	1565	0.174	4890	3039	3039	0	1114	434	434	165	103	103	32	364	0				
Jun-39	0.291	0.28	689	4214	11107	11543	4214	2102	2102	1403	1458	0	0	0	2871	0.264	4890	4611	3984	0	0	874	874	165	156	156	78	789	0				
Jul-39	0.515	0.28	1252	6247	11107	20429	6247	3226	3226	1403	2581	0	0	0	4478	0.471	4890	8226	4478	0	0	1169	1169	165	278	278	129	1021	0				
Aug-39	0.409	0.50	938	1125	11107	9086	1125	1972	1972	1403	1140	0	0	0	2983	0.354	4890	3462	2983	0	0	887	887	165	117	117	98	868	0	14484	4933		
Sep-39	0.171	0.50	416	0	11107	3799	0	738	738	1403	480	0	0	0	1154					0	1154	379	379				42	422					
Oct-39		0.50	77	0				67	68					0	145					0	1299	88	88				7	87					
Nov-39			6	1				0	1					0	7					0	1386		0				0	0					
Dec-39			0	74					74						74					0	1388		0					0					
Jan-40			0	66					66						66					0	1446		0					0					
Feb-40			0	215					215						215					0	1660		0					0					
Mar-40			0	382					382						382					0	2042		0					0					
Apr-40		0.28	0	3					3						3					0	2045		0					0					
May-40	0.195	0.28	314	3912	11107	7735	3912	1213	1213	1403	977	0	0	0	1527	0.174	4890	3039	3039	0	533	434	434	165	103	103	32	364	0				
Jun-40	0.291	0.28	689	2520	11107	11543	2520	1638	1638	1403	1458	0	0	0	2319	0.264	4890	4611	2852	0	0	712	712	165	156	156	78	627	0				
Jul-40	0.515	0.28	1085	5810	11107	20429	5810	2712	2712	1403	2581	0	0	0	3796	0.471	4890	8226	3796	0	0	958	958	165	278	278	129	818	0				
Aug-40	0.409	0.50	686	1123	11107	9086	1123	1720	1720	1403	1140	0	0	0	2405	0.354	4890	3462	2405	0	0	724	724	165	117	117	98	705	0	12092	7245		
Sep-40	0.171	0.50	275	0	11107	3799	0	698	698	1403	480	0	0	0	974					0	974	318	318				42	360					
Oct-40		0.50	39	0				67	68					0	107					0	1000	67	67				7	74					
Nov-40			6	1				0	1					0	7					0	1007		0				0	0					
Dec-40			0	0					0						0					0	1007		0					0					
Jan-41			0	0					0						0					0	1008		0					0					
Feb-41			0	4					4						4					0	1091		0					0					
Mar-41			0	0					0						0					0	1092		0					0					
Apr-41		0.28	0	0					0						0					0	1092		0					0					
May-41	0.195	0.28	314	3886	11107	7735	3886	1205	1205	1403	977	0	0	0	1519	0.174	4890	3039	2610	0	-0	373	373	165	103	103	32	302	0				
Jun-41	0.291	0.28	634	2652	11107	11543	2652	1665	1665	1403	1458	0	0	0	2299	0.264	4890	4611	2299	0	-0	590	590	165	156	156	78	585	0				
Jul-41	0.515	0.28	1059	6042	11107	20429	6042	2818	2818	1403	2581	0	0	0	3860	0.471	4890	8226	3860	0	-0	894	894	165	278	278	129	746	0				
Aug-41	0.409	0.50	785	1519	11107	9086	1519	1861	1861	1403	1140	0	0	0	2566	0.354	4890	3462	2566	0	-0	722	722	165	117	117	98	703	0	11336	8002		
Sep-41	0.171	0.50	300	0	11107	3799	0	775	775	1403	480	0	0	0	1075					0	1075	331	331				42	373					
Oct-41		0.50	49	1				91	92					0	141					0	1216	71	71				7	78					
Nov-41			6	10				0	10					0	17					0	1232		0				0	0					
Dec-41			0	825					825						825					0	2058		0					0					
Jan-42			0	651					651						651					0	2709		0					0					
Feb-42			0	571					571						571					0	3279		0					0					
Mar-42			0	674					674						674					0	3953		0					0					
Apr-42		0.28	0	3732					3732						3732					0	7685		0					0					
May-42	0.195	0.28	314	6665	11107	7735	6665	2066	2066	1403	977	0	0	0	2380	0.174	4890	3039	3039	0	7027	434	434	165	103	103	32	364	0				
Jun-42	0.291	0.28	2979	10489	11107	11543	10489	4698	4698	1402	1458	904	904	288	7854	0.264	4890	4611	4611	0	9470	963	963	165	156	156	78	878	0				
Jul-42	0.515	0.28	1252	6881	11107	20429	6881	5084	5084	1403	2581	0	0	196	6452	0.471	4890	8226	8226	0	7697	1768	1768	165	278	278	129	1619	0				
Aug-42	0.409	0.50	959	1739	11107	9086	1739	2799	2799	1403	1140	0	0	84	3843	0.354	4890	3462	3462	0	8077	1340	1340	165	117	117	98	1321	0	19337	0		
Sep-42	0.171	0.50	515	118	11107	3799	118	900	900	1403	480	27	27	5	1393					0	9470	576	576				42	618					
Oct-42		0.50	141	0				121	121					4	266					266	9470	96	362				7	369					
Nov-42			38	1				7	8					2	39					39	9470		39				0	39					
Dec-42			0	439					439						439					439	9470		439					439					
Jan-43			0	499					499						499					499	9470		499					499					
Feb-43			0	1153					1153						1153					1153	9470		1153					1153					

Petrolia Normal Storage (AF) = 9470 , Dead Storage = 0

(A) Date	(B) NIR Above Petrolia	(C) Eff Above Petrolia	(D) YW Cr Entering Petrolia	(E) FW Cr Above Petrolia	(F) Pre 1950 Acres Abv Petrolia	(G) Pre 1950 Desired Diversion	(H) Pre 1950 Actual Diversion	(I) Return Flow	(J) Stream Flow	(K) Post 1950 Acres Abv Petrolia	(L) Post 1950 Desired Diversion	(M) Available Flow After Pet Rights	(N) Post 1950 Actual Diversion	(O) Return Flow	(P) Petrolia Reservoir Inflow	(Q) NIR Below Petrolia	(R) Pet 1950 Acres Below Res	(S) Pet 1950 Desired Diversion	(T) Pet 1950 Actual Diversion	(U) Spilled Flow	(V) Petrolia Res EOM Storage	(W) Pet. 1950 Return Flow	(X) Stream Flow	(Y) Pre 1950 Damschen Acres	(Z) Damschen Desired Diversion	(AA) Damschen Actual Diversion	(AB) Damschen Return Flow	(AC) Stream Flow	(AD) Pre 1950 Damschen Shortage	(AE) Pet. 1950 Total Ann. Diversion	(AF) Pet. 1950 Total Ann Shortage	(AG) Weibull Plotting Position	(AH) Sorted Pet Ann Yields
Mar-43			651	1978					1978						2630					2630	9470		2630						2630					
Apr-43		0.28	237	574					574						811					811	9470		811						811					
May-43	0.195	0.28	807	4295	11107	7735	4295	1331	1331	1403	977	0	0	0	2138	0.174	4890	3039	3039	0	8569	434	434	165	103	103	32	364	0				
Jun-43	0.291	0.28	3266	10642	11107	11543	10642	4231	4231	1403	1458	1458	1458	452	6485	0.264	4890	4611	4611	973	9470	963	1937	165	156	156	70	1851	0				
Jul-43	0.515	0.28	1252	7472	11107	20429	7472	5025	5025	1403	2581	0	0	316	6593	0.471	4890	8226	8226	0	7838	1768	1768	165	278	278	129	1619	0				
Aug-43	0.489	0.50	959	1538	11107	9086	1538	2919	2919	1403	1148	0	0	136	4614	0.354	4890	3462	3462	0	8389	1340	1340	165	117	117	98	1321	0	19337	0		
Sep-43	0.171	0.50	515	0	11107	3799	0	918	918	1403	480	431	431	86	1861					0	9470	576	576				42	618					
Oct-43		0.50	141	0				92	93					60	294					294	9470	96	390				7	397					
Nov-43			38	1				0	1					26	56					56	9470		56				0	56					
Dec-43			0	365					365						365					365	9470		365					365					
Jan-44			0	286					286						286					286	9470		286					286					
Feb-44			0	333					333						333					333	9470		333					333					
Mar-44			0	788					788						788					788	9470		788					788					
Apr-44		0.28	0	71					71						71					71	9470		71					71					
May-44	0.195	0.28	512	3945	11107	7735	3945	1223	1223	1403	977	0	0	0	1735	0.174	4890	3039	3039	0	8167	434	434	165	103	103	32	364	0				
Jun-44	0.291	0.28	1084	5382	11107	11543	5382	2525	2525	1403	1458	0	0	0	3668	0.264	4890	4611	4611	0	7165	963	963	165	156	156	70	878	0				
Jul-44	0.515	0.28	1252	7051	11107	20429	7051	3721	3721	1403	2581	0	0	0	4973	0.471	4890	8226	8226	0	3912	1768	1768	165	278	278	129	1619	0				
Aug-44	0.489	0.50	959	1491	11107	9086	1491	2329	2329	1403	1148	0	0	0	3288	0.354	4890	3462	3462	0	3738	1340	1340	165	117	117	98	1321	0	19337	0		
Sep-44	0.171	0.50	515	0	11107	3799	0	864	864	1403	480	0	0	0	1379					0	5117	576	576				42	618					
Oct-44		0.50	141	0				89	90					0	231					0	5348	96	96				7	103					
Nov-44			38	1				0	1					0	38					0	5378		0				0	0					
Dec-44			0	296					296						296					0	5675		0					0					
Jan-45			0	269					269						269					0	5943		0					0					
Feb-45			0	224					224						224					0	6168		0					0					
Mar-45			0	373					373						373					0	6540		0					0					
Apr-45		0.28	0	2					2						2					0	6543		0					0					
May-45	0.195	0.28	314	3922	11107	7735	3922	1216	1216	1403	977	0	0	0	1530	0.174	4890	3039	3039	0	5034	434	434	165	103	103	32	364	0				
Jun-45	0.291	0.28	689	4070	11107	11543	4070	2113	2113	1403	1458	0	0	0	2802	0.264	4890	4611	4611	0	3225	963	963	165	156	156	70	878	0				
Jul-45	0.515	0.28	1252	6022	11107	20429	6022	3115	3115	1403	2581	0	0	0	4367	0.471	4890	8226	7592	0	0	1677	1677	165	278	278	129	1529	0				
Aug-45	0.489	0.50	959	1125	11107	9086	1125	1918	1918	1403	1148	0	0	0	2870	0.354	4890	3462	2870	0	0	1222	1222	165	117	117	98	1203	0	18111	1226		
Sep-45	0.171	0.50	515	0	11107	3799	0	718	718	1403	480	0	0	0	1233					0	1233	511	511				42	553					
Oct-45		0.50	141	0				68	68					0	209					0	1442	79	79				7	86					
Nov-45			38	1				0	1					0	38					0	1472		0				0	0					
Dec-45			0	134					134						134					0	1606		0					0					
Jan-46			0	305					305						305					0	1912		0					0					
Feb-46			0	302					302						302					0	2213		0					0					
Mar-46			0	405					405						405					0	2619		0					0					
Apr-46		0.28	0	4					4						4					0	2623		0					0					
May-46	0.195	0.28	314	3947	11107	7735	3947	1224	1224	1403	977	0	0	0	1538	0.174	4890	3039	3039	0	1122	434	434	165	103	103	32	364	0				
Jun-46	0.291	0.28	689	3167	11107	11543	3167	1838	1838	1403	1458	0	0	0	2527	0.264	4890	4611	3649	0	-0	826	826	165	156	156	70	741	0				
Jul-46	0.515	0.28	1252	5914	11107	20429	5914	2888	2888	1403	2581	0	0	0	4139	0.471	4890	8226	4139	0	-0	1087	1087	165	278	278	129	939	0				
Aug-46	0.489	0.50	959	1123	11107	9086	1123	1802	1802	1403	1148	0	0	0	2762	0.354	4890	3462	2762	0	-0	825	825	165	117	117	98	807	0	13588	5749		
Sep-46	0.171	0.50	515	0	11107	3799	0	707	707	1403	480	0	0	0	1222					0	1222	356	356				42	398					
Oct-46		0.50	141	0				67	68					0	209					0	1431	76	76				7	83					
Nov-46			38	1				0	1					0	38					0	1462		0				0	0					
Dec-46			0	178					178						178					0	1640		0					0					
Jan-47			0	151					151						151					0	1790		0					0					
Feb-47			0	270					270						270					0	2060		0					0					
Mar-47			0	1761					1761						1761					0	3821		0					0					
Apr-47		0.28	0	3835					3835						3835					0	7656		0					0					
May-47	0.195	0.28	314	4129	11107	7735	4129	1280	1280	1403	977	0	0	0	1594	0.174	4890	3039	3039	0	6211	434	434	165	103	103	32	364	0				

Petrolia Normal Storage (AF) = 9470 , Dead Storage = 0

(A) Date	(B) NIR Above Petrolia	(C) Eff Above Petrolia	(D) FW Cr Entering Petrolia	(E) FW Cr Above Petrolia	(F) Pre 1950 Acres Abv Petrolia	(G) Pre 1950 Desired Diversion	(H) Pre 1950 Actual Diversion	(I) Return Flow	(J) Stream Flow	(K) Post 1950 Acres Abv Petrolia	(L) Post 1950 Desired Diversion	(M) Available Flow After Pet Rights	(N) Post 1950 Actual Diversion	(O) Return Flow	(P) Petrolia Reservoir Inflow	(Q) NIR Below Petrolia	(R) Pet 1950 Acres Below Res	(S) Pet 1950 Desired Diversion	(T) Pet 1950 Actual Diversion	(U) Spilled Flow	(V) Petrolia Res EOM Storage	(W) Pet. 1950 Return Flow	(X) Stream Flow	(Y) Pre 1950 Damschen Acres	(Z) Damschen Desired Diversion	(AA) Damschee Actual Diversion	(AB) Damschen Return Flow	(AC) Stream Flow	(AD) Pre 1950 Damschen Shortage	(AE) Pet. 1950 Total Ann. Diversion	(AF) Pet. 1950 Total Ann Shortage	(AG) Weibull Plotting Position	(AH) Sorted Pet Ann Yields
Jun-47	0.291	0.28	689	3841	11107	11543	3841	2087	2087	1403	1458	0	8	0	2776	0.264	4890	4611	4611	0	4376	963	963	165	156	156	70	878	0				
Jul-47	0.515	0.28	1252	5950	11107	20429	5950	3062	3062	1403	2581	0	0	0	4314	0.471	4890	8226	8226	0	464	1768	1768	165	278	278	129	1619	0				
Aug-47	0.409	0.50	959	1131	11107	9836	1131	1875	1875	1403	1148	0	0	0	2834	0.354	4890	3462	3298	0	0	1325	1325	165	117	117	98	1306	0	19173	164		
Sep-47	0.171	0.50	515	0	11107	3799	0	712	712	1403	480	0	0	0	1227					0	1227	566	566				42	608					
Oct-47		0.50	141	0				65	65					0	289					0	1436	91	91				7	98					
Nov-47			38	1				0	1					0	38					0	1467		0				0	0					
Dec-47			0	143					143						143					0	1610		0					0				
Jan-48			0	221					221						221					0	1831		0					0				
Feb-48			0	240					240						240					0	2071		0					0				
Mar-48			0	479					479						479					0	2550		0					0				
Apr-48		0.28	0	58					58						58					0	2608		0					0				
May-48	0.195	0.28	314	4738	11107	7735	4738	1469	1469	1403	977	0	0	0	1783	0.174	4890	3039	3039	0	1352	434	434	165	103	103	32	364	0				
Jun-48	0.291	0.28	2531	10359	11107	11543	10359	4249	4249	1403	1458	0	0	0	6780	0.264	4890	4611	4611	0	3521	963	963	165	156	156	70	878	0				
Jul-48	0.515	0.28	3163	12368	11107	20429	12368	6511	6511	1403	2581	0	0	0	9613	0.471	4890	8226	8226	0	4909	1768	1768	165	278	278	129	1619	0				
Aug-48	0.409	0.50	959	1683	11107	9836	1683	3974	3974	1403	1148	0	0	0	4933	0.354	4890	3462	3462	0	6380	1340	1340	165	117	117	98	1321	0	19337	0		
Sep-48	0.171	0.50	515	0	11107	3799	0	1380	1380	1403	486	0	0	0	1895					8	8275	576	576				42	618					
Oct-48		0.50	141	0				101	101					0	242					0	8518	96	96				7	103					
Nov-48			38	99				0	99					0	129					0	8647		0				0	0				
Dec-48			0	185					185						185					0	8832		0					0				
Jan-49			0	140					140						140					0	8971		0					0				
Feb-49			0	580					580						580					81	9470		81					81				
Mar-49			1028	3394					3394						4421					4421	9470		4421					4421				
Apr-49		0.28	160	386					386						545					545	9470		545					545				
May-49	0.195	0.28	796	4270	11107	7735	4270	1324	1324	1403	977	0	0	0	2126	0.174	4890	3039	3039	0	8551	434	434	165	103	103	32	364	0				
Jun-49	0.291	0.28	986	4953	11107	11543	4953	2462	2462	1403	1458	0	0	0	3306	0.264	4890	4611	4611	0	7309	963	963	165	156	156	70	878	0				
Jul-49	0.515	0.28	1468	8326	11107	20429	8326	4053	4053	1403	2581	0	0	0	5521	0.471	4890	8226	8226	0	4605	1768	1768	165	278	278	129	1619	0				
Aug-49	0.409	0.50	959	1353	11107	9836	1353	2538	2538	1403	1148	0	0	0	3497	0.354	4890	3462	3462	0	4640	1340	1340	165	117	117	98	1321	0	19337	0		
Sep-49	0.171	0.50	515	0	11107	3799	0	964	964	1403	480	0	0	0	1479					0	6119	576	576				42	618					
Oct-49		0.50	141	0				81	82					0	223					0	6341	96	96				7	103					
Nov-49			38	0				0	0					0	38					0	6372		0				0	0				
Dec-49			0	0					0						0					0	6372		0					0				
Jan-50			0	0					0						0					0	6372		0					0				
Feb-50			0	23					23						23					0	6372		0					0				
Mar-50			0	847					847						847					0	6395		0					0				
Apr-50		0.28	0	562					562						562					0	7242		0					0				
May-50	0.195	0.28	454	4252	11107	7735	4252	1318	1318	1403	977	0	0	0	1772	0.174	4890	3039	3039	0	7804		0					0				
Jun-50	0.291	0.28	1024	5237	11107	11543	5237	2546	2546	1403	1458	0	0	0	3570	0.264	4890	4611	4611	0	6536	434	434	165	103	103	32	364	0				
Jul-50	0.515	0.28	1626	8706	11107	20429	8706	4231	4231	1403	2581	0	0	0	5856	0.471	4890	8226	8226	0	5496	963	963	165	156	156	70	878	0				
Aug-50	0.409	0.50	959	1278	11107	9836	1278	2652	2652	1403	1148	0	0	0	3611	0.354	4890	3462	3462	0	3126	1768	1768	165	278	278	129	1619	0				
Sep-50	0.171	0.50	515	0	11107	3799	0	1003	1003	1403	480	0	0	0	1518					0	3275	1340	1340	165	117	117	98	1321	0	19337	0		
Oct-50		0.50	141	0				83	83					0	224					0	4793	576	576				42	618					
Nov-50			38	0				0	0					0	38					0	5017	96	96				7	103					
Dec-50			0	183					183						183					0	5047		0				0	0				
			0	126																0	5151		0					0				
			0	212																													
			0	1331																													
			283	1129																													

Total Damschen Shortage (af)= 0
Firm Petrolia Yield (af) = 10810
80% Petrolia Yield (af) = 12401

Petrolia Normal Storage (AF) = 11200 Dead Storage = 0

(A) Date	(B) NIR Above Petrolia	(C) Eff Above Petrolia	(D) YW Cr Entering Petrolia	(E) FW Cr Above Petrolia	(F) Pre 1950 Acres Abv Petrolia	(G) Pre 1950 Desired Diversion	(H) Pre 1950 Actual Diversion	(I) Return Flow	(J) Stream Flow	(K) Post 1950 Acres Abv Petrolia	(L) Post 1950 Desired Diversion	(M) Available Flow After Pet Rights	(N) Post 1950 Actual Diversion	(O) Return Flow	(P) Petrolia Reservoir Inflow	(Q) NIR Below Petrolia	(R) Pet 1950 Acres Below Res	(S) Pet 1950 Desired Diversion	(T) Pet 1950 Actual Diversion	(U) Spilled Flow	(V) Petrolia Res EOM Storage	(W) Pet. 1950 Return Flow	(X) Stream Flow	(Y) Pre 1950 Damschen Acres	(Z) Damschen Desired Diversion	(AA) Damschen Actual Diversion	(AB) Damschen Return Flow	(AC) Stream Flow	(AD) Pre 1950 Damschen Shortage	(AE) Pet. 1950 Total Ann. Diversion	(AF) Pet. 1950 Total Ann Shortage	(AG) Weibull Plotting Position	(AH) Sorted Pet Ann Yields
Jan-22			334	806					806						1140					1140	11200		1140					1140				0.033	19337
Feb-22			232	568					568						791					791	11200		791					791				0.067	19337
Mar-22			2474	5981					5981						8455					8455	11200		8455					8455				0.100	19337
Apr-22		0.28	1393	3367					3367						4760					4760	11200		4760					4760				0.133	19337
May-22	0.195	0.28	2389	8119	11107	7735	7735	2398	2782	1403	977	977	977	303	4497	0.174	4890	3039	3039	1458	11200	434	1892	165	103	103	32	1822	0			0.167	19337
Jun-22	0.291	0.28	5653	1n427	11107	11543	11543	5257	10141	1403	1458	1458	1458	664	15000	0.264	4890	4611	4611	10389	11200	963	11352	165	156	156	70	11267	0			0.200	19337
Jul-22	0.515	0.28	1411	8188	11107	20429	8188	5763	5763	1403	2581	0	0	407	7581	0.471	4890	8226	8226	0	10555	1768	1768	165	278	278	129	1619	0			0.233	19337
Aug-22	0.489	0.50	959	1214	11107	9086	1214	3093	3093	1403	1148	102	102	156	4107	0.354	4890	3462	3462	0	11200	1340	1340	165	117	117	98	1321	0	19337	0	0.267	19337
Sep-22	0.171	0.50	515	0	11107	3799	0	932	932	1403	480	480	480	110	1077					1077	11200	576	1653				42	1695				0.300	19337
Oct-22		0.50	141	0				73	73					73	288					288	11200	96	383				7	390				0.333	19337
Nov-22			30	605				0	605					29	664					664	11200		664				0	664				0.367	19337
Dec-22			0	827					827						827					827	11200		827					827				0.400	19337
Jan-23			0	941					941						941					941	11200		941					941				0.433	19337
Feb-23			274	672					672						946					946	11200		946					946				0.467	19337
Mar-23			500	1210					1210						1710					1710	11200		1710					1710				0.500	19337
Apr-23		0.28	879	2123					2123						3802					3802	11200		3802					3802				0.533	19337
May-23	0.195	0.28	1218	5296	11107	7735	5290	1640	1640	1403	977	0	0	0	2858	0.174	4890	3039	3039	0	11020	434	434	165	103	103	32	364	0			0.567	19337
Jun-23	0.291	0.28	8489	23281	11107	11543	11543	4726	16404	1403	1458	1458	1458	452	23947	0.264	4890	4611	4611	19156	11200	963	20120	165	156	156	70	20034	0			0.600	19337
Jul-23	0.515	0.28	9660	28126	11107	20429	20429	9330	17027	1403	2581	2581	2581	1116	25223	0.471	4890	8226	8226	16997	11200	1768	18764	165	278	278	129	18616	0			0.633	19337
Aug-23	0.489	0.50	2305	6346	11107	9086	6346	6776	6776	1403	1148	1148	1148	925	8859	0.354	4890	3462	3462	5397	11200	1340	6737	165	117	117	98	6718	0	19337	0	0.667	19173
Sep-23	0.171	0.50	1087	2568	11107	3799	2568	3302	3302	1403	480	480	480	497	4406					4406	11200	576	4982				42	5024				0.700	14525
Oct-23		0.50	1401	2913				740	3653					136	5190					5190	11200	96	5286				7	5293				0.733	14404
Nov-23			1131	2635				154	2789					29	3949					3949	11200		3949				0	3949				0.767	14092
Dec-23			862	2083					2083						2945					2945	11200		2945					2945				0.800	12401
Jan-24			695	1680					1680						2375					2375	11200		2375					2375				0.833	12092
Feb-24			556	1344					1344						1900					1900	11200		1900					1900				0.867	11336
Mar-24			1026	2480					2480						3506					3506	11200		3506					3506				0.900	11224
Apr-24		0.28	3364	8131					8131						11495					11495	11200		11495					11495				0.933	10929
May-24	0.195	0.28	3987	11983	11107	7735	7735	2398	6646	1403	977	977	977	303	9959	0.174	4890	3039	3039	6920	11200	434	7355	165	103	103	32	7284	0			0.967	10810
Jun-24	0.291	0.28	4347	13269	11107	11543	11543	5257	6982	1403	1458	1458	1458	664	10535	0.264	4890	4611	4611	5924	11200	963	6887	165	156	156	70	6802	0				
Jul-24	0.515	0.28	2365	18493	11107	20429	18493	6477	6477	1403	2581	1483	1483	867	8226	0.471	4890	8226	8226	0	11200	1768	1768	165	278	278	129	1619	0				
Aug-24	0.489	0.50	959	2314	11107	9086	2314	3813	3813	1403	1148	1148	1148	687	4312	0.354	4890	3462	3462	850	11200	1340	2190	165	117	117	98	2171	0	19337	0		
Sep-24	0.171	0.50	515	522	11107	3799	522	1484	1484	1403	480	480	480	395	1834					1834	11200	576	2410				42	2452					
Oct-24		0.50	141	312				212	524					136	801					801	11200	96	897				7	904					
Nov-24			194	1022				31	1053					29	1276					1276	11200		1276				0	1276					
Dec-24			512	1236					1236						1748					1748	11200		1748					1748					
Jan-25			428	1035					1035						1463					1463	11200		1463					1463					
Feb-25			500	1210					1210						1710					1710	11200		1710					1710					
Mar-25			1368	3306					3306						4674					4674	11200		4674					4674					
Apr-25		0.28	973	2352					2352						3325					3325	11200		3325					3325					
May-25	0.195	0.28	818	4323	11107	7735	4323	1340	1340	1403	977	0	0	0	2158	0.174	4890	3039	3039	0	10319	434	434	165	103	103	32	364	0				
Jun-25	0.291	0.28	1133	5500	11107	11543	5500	2643	2643	1403	1458	0	0	0	3776	0.264	4890	4611	4611	0	9485	963	963	165	156	156	70	878	0				
Jul-25	0.515	0.28	1252	7082	11107	20429	7082	3791	3791	1403	2581	0	0	0	5043	0.471	4890	8226	8226	0	6302	1768	1768	165	278	278	129	1619	0				
Aug-25	0.489	0.50	959	1139	11107	9086	1139	2276	2276	1403	1148	0	0	0	3235	0.354	4890	3462	3462	0	6075	1340	1340	165	117	117	98	1321	0	19337	0		
Sep-25	0.171	0.50	515	0	11107	3799	0	818	818	1403	480	0	0	0	1333					0	7489	576	576				42	618					
Oct-25		0.50	141	0				68	69					0	210					0	7618	96	96				7	103					
Nov-25			30	456				0	456					0	486					0	8104		0				0	0					
Dec-25			0	531					531						531					0	8635		0					0					
Jan-26			0	331					331						331					0	8966		0					0					
Feb-26			0	298					298						298					0	9264		0					0					

Petrolia Normal Storage (AF) = 11.00 , Dead Storage = 0

(A) Date	(B) NIR Above Petrolia	(C) Evap Above Petrolia	(D) Yuba Cr Entering Petrolia	(E) FW Cr Above Petrolia	(F) Pre 1950 Acres Abv Petrolia	(G) Pre 1950 Desired Diversion	(H) Pre 1950 Actual Diversion	(I) Return Flow	(J) Stream Flow	(K) Post 1950 Acres Abv Petrolia	(L) Post 1950 Desired Diversion	(M) Available Flow After Pet Rights	(N) Post 1950 Actual Diversion	(O) Return Flow	(P) Petrolia Reservoir Inflow	(Q) NIR Below Petrolia	(R) Pet 1950 Acres Below Res	(S) Pet 1950 Desired Diversion	(T) Pet 1950 Actual Diversion	(U) Spilled Flow	(V) Petrolia Res EOM Storage	(W) Pet. 1950 Return Flow	(X) Stream Flow	(Y) Pre 1950 Damscheo Acres	(Z) Damscheo Desired Diversion	1AA) Damscheo Actual Diversion	(AB) Damscheo Return Flow	(AC) Stream Flow	(AD) Pre 1950 Damscheo Shortage	(AE) Pet. 1950 Total Ann. Diversion	(AF) Pet. 1950 Total Ann Shortage	(AG) Weibull Plotting Position	(AH) Sorted Pet Ann Yields
Mar-26			0	331					331						331					0	9595		0					0				
Apr-26		0.28	0	444					444						444					0	10038		0					0				
May-26	0.195	0.28	314	3471	11107	7735	3471	1076	1076	1403	977	0	0	0	1390	0.174	4890	3039	3039	0	8390	434	434	165	103	103	32	364	0			
Jun-26	0.291	0.28	689	4062	11107	11543	4062	2013	2013	1403	1458	0	0	0	2701	0.264	4890	4611	4611	0	6480	963	963	165	156	156	70	878	0			
Jul-26	0.515	0.28	1252	7098	11107	20429	7098	3405	3405	1403	2581	0	0	0	4557	0.471	4890	8226	8226	0	2911	1760	1768	165	278	278	129	1619	0			
Aug-26	0.409	0.56	959	1139	11107	9086	1139	2146	2146	1403	1148	0	0	0	3105	0.354	4890	3462	3462	0	2555	1340	1340	165	117	117	98	1321	0	19337	0	
Sep-26	0.171	0.58	515	0	11107	3799	0	820	820	1403	488	0	0	0	1335					0	3889	576	576				42	618				
Oct-26		0.58	141	588				68	656					0	797					0	4686	96	96				7	103				
Nov-26			30	0				0	0					0	30					0	4716		0				0	0				
Dec-26			0	289					289						289					0	5005		0					0				
Jan-27			0	202					202						202					0	5207		0					0				
Feb-27			0	181					181						181					0	5388		0					0				
Mar-27			662	3360					3360						4022					0	9411		0					0				
Apr-27		0.28	601	1451					1451						2052					263	11200		263					263				
May-27	0.195	0.28	8102	21929	11107	7735	7735	2398	16591	1403	977	977	977	303	24819	0.174	4890	3039	3039	20980	11200	434	21415	165	103	103	32	21344	0			
Jun-27	0.291	0.28	7433	28728	11107	11543	11543	5257	14441	1403	1458	1458	1458	664	21080	0.264	4890	4611	4611	16469	11200	963	17432	165	156	156	70	17347	0			
Jul-27	0.515	0.28	2278	16264	11107	20429	16264	6406	6406	1403	2581	1244	1244	793	8226	0.471	4890	8226	8226	0	11200	1768	1768	165	278	278	129	1619	0			
Aug-27	0.409	0.58	959	1925	11107	9086	1925	3686	3686	1403	1148	1148	1148	635	4133	0.354	4890	3462	3462	671	11200	1340	2011	165	117	117	98	1992	0	19337	0	
Sep-27	0.171	0.58	515	855	11107	3799	855	1395	1395	1403	488	488	488	372	1883					1883	11200	576	2379				42	2421				
Oct-27		0.58	141	688				235	924					136	1201					1201	11200	96	1296				7	1303				
Nov-27			509	1465				51	1517					29	2055					2055	11200		2055				0	2055				
Dec-27			584	1411					1411						1995					1995	11200		1995					1995				
Jan-28			508	1210					1210						1718					1718	11200		1718					1718				
Feb-28			417	1008					1008						1425					1425	11200		1425					1425				
Mar-28			890	2150					2150						3040					3040	11200		3040					3040				
Apr-28		0.28	948	2271					2271						3211					3211	11200		3211					3211				
May-28	0.195	0.28	1871	4934	11107	7735	4934	1538	1538	1403	977	0	0	0	2601	0.174	4890	3039	3039	0	10762	434	434	165	103	103	32	364	0			
Jun-28	0.291	0.28	689	4242	11107	11543	4242	2386	2386	1403	1458	0	0	0	3875	0.264	4890	4611	4611	0	9226	963	963	165	156	156	70	878	0			
Jul-28	0.515	0.28	1743	9048	11107	20429	9048	4184	4184	1403	2581	0	0	0	5928	0.471	4890	8226	8226	0	6928	1768	1768	165	278	278	129	1619	0			
Aug-28	0.409	0.58	959	1298	11107	9086	1298	2618	2618	1403	1148	0	0	0	3577	0.354	4890	3462	3462	0	7043	1340	1340	165	117	117	98	1321	0	19337	0	
Sep-28	0.171	0.58	515	86	11107	3799	86	1048	1048	1403	488	0	0	0	1555					0	8598	576	576				42	618				
Oct-28		0.58	141	0				90	90					0	231					0	8829	96	96				7	103				
Nov-28			30	343				5	348					0	378					0	9208		0				0	0				
Dec-28			0	470					470						470					0	9678		0					0				
Jan-29			0	413					413						413					0	10091		0					0				
Feb-29			0	373					373						373					0	10464		0					0				
Mar-29			1661	4704					4704						6365					5629	11200		5629					5629				
Apr-29		0.28	603	1458					1458						2061					2061	11200		2061					2061				
May-29	0.195	0.28	1513	6003	11107	7735	6003	1861	1861	1403	977	486	486	151	3039	0.174	4890	3039	3039	0	11200	434	434	165	103	103	32	364	0			
Jun-29	0.291	0.28	1953	7483	11107	11543	7483	3622	3622	1403	1458	1458	1458	557	4675	0.264	4890	4611	4611	64	11200	963	1027	165	156	156	70	942	0			
Jul-29	0.515	0.28	1252	7398	11107	20429	7398	4475	4475	1403	2581	0	0	362	6089	0.471	4890	8226	8226	0	9863	1768	1768	165	278	278	129	1619	0			
Aug-29	0.409	0.58	959	1139	11107	9086	1139	2529	2529	1403	1148	0	0	136	3624	0.354	4890	3462	3462	0	9225	1340	1340	165	117	117	98	1321	0	19337	0	
Sep-29	0.171	0.58	515	0	11107	3799	0	848	848	1403	488	0	0	0	1363					0	10588	576	576				42	618				
Oct-29		0.58	141	0				68	69					0	210					0	10798	96	96				7	103				
Nov-29			30	181				0	181					0	211					0	11008		0				0	0				
Dec-29			0	381					381						381					189	11200		189					189				
Jan-30			0	374					374						374					374	11200		374					374				
Feb-30			0	607					607						607					607	11200		607					607				
Mar-30			486	2271					2271						2757					2757	11200		2757					2757				
Apr-30		0.28	884	2137					2137						3021					3021	11200		3021					3021				
May-30	0.195	0.28	1172	5178	11107	7735	5178	1685	1685	1403	977	0	0	0	2777	0.174	4890	3039	3039	0	10939	434	434	165	103	103	32	364	0			

Petrolia Normal Storage (AF) = 11200 , Dead Storage = 0

(A) Date	(B) NIR Above Petrolia	(C) Eff Above Petrolia	(D) Yw Cr Entering Petrolia	(E) Fw Cr Above Petrolia	(F) Pre 1950 Acres Abv Petrolia	(G) Pre 1950 Desired Diversion	(H) Pre 1950 Actual Diversion	(I) Return Flow	(J) Stream Flow	(K) Post 1950 Acres Abv Petrolia	(L) Post 1950 Desired Diversion	(M) Available Flow After Pet Rights	(N) Post 1950 Actual Diversion	(O) Return Flow	(P) Petrolia Reservoir Inflow	(Q) NIR Below Petrolia	(R) Pet 1950 Acres Below Res	(S) Pet 1950 Desired Diversion	(T) Pet 1950 Actual Diversion	(U) Spilled Flow	(V) Petrolia Res EOM Storage	(W) Pet. 1950 Return Flow	(X) Stream Flow	(Y) Pre 1950 Damschen Acres	(Z) Damschen Desired Diversion	(AA) Damschen Actual Diversion	(AB) Damschen Return Flow	(AC) Stream Flow	(AD) Pre 1950 Damschen Shortage	(AE) Pet. 1950 Total Ann. Diversion	(AF) Pet. 1950 Total Ann Shortage	(AG) Weibull Plotting Position	(AH) Sorted Pet Ann Yields
Jun-30	0.291	0.28	810	4721	11107	11543	4721	2587	2587	1403	1458	0	0	0	3397	0.264	4890	4611	4611	0	9725	963	963	165	156	156	70	878	0				
Jul-30	0.515	0.28	1478	8330	11107	20429	8330	4088	4088	1403	2581	0	0	0	5558	0.471	4890	8226	8226	0	7058	1768	1768	165	278	278	129	1619	0				
Aug-30	0.489	0.50	959	1303	11107	9086	1303	2507	2507	1403	1148	0	0	0	3467	0.354	4890	3462	3462	0	7063	1340	1348	165	117	117	98	1321	0	19337	0		
Sep-30	0.171	0.50	515	21	11107	3799	21	961	961	1403	480	0	0	0	1476					0	8539	576	576				42	618					
Oct-30		0.50	141	0				81	81					0	222					0	8761	96	96				7	103					
Nov-30			30	0				1	2					0	31					0	8793		0				0	0					
Dec-30			0	241					241						241					0	9034		0					0				
Jan-31			0	687					687						687					0	9722		0					0				
Feb-31			0	653					653						653					0	10375		0					0				
Mar-31			0	359					359						359					0	10734		0					0				
Apr-31		0.28	0	41					41						41					0	10775		0					0				
May-31	0.195	0.28	538	3949	11107	7735	3949	1224	1224	1403	977	0	0	0	1762	0.174	4890	3039	3039	0	9499	434	434	165	103	103	32	364	0				
Jun-31	0.291	0.28	781	4651	11107	11543	4651	2299	2299	1403	1458	0	0	0	3080	0.264	4890	4611	4611	0	7968	963	963	165	156	156	70	878	0				
Jul-31	0.515	0.28	1351	8043	11107	20429	8043	3870	3870	1403	2581	0	0	0	5221	0.471	4890	8226	8226	0	4963	1768	1768	165	278	278	129	1619	0				
Aug-31	0.489	0.50	959	1303	11107	9086	1303	2439	2439	1403	1148	0	0	0	3398	0.354	4890	3462	3462	0	4899	1340	1340	165	117	117	98	1321	0	19337	0		
Sep-31	0.171	0.50	515	0	11107	3799	0	931	931	1403	480	0	0	0	1446					0	6345	576	576				42	618					
Oct-31		0.50	141	0				78	79					0	220					0	6564	96	96				7	103					
Nov-31			30	0				0	0					0	30					0	6594		0				0	0				
Dec-31			0	0					0						0					0	6595		0					0				
Jan-32			0	0					0						0					0	6595		0					0				
Feb-32			0	4					4						4					0	6599		0					0				
Mar-32			0	0					0						0					0	6599		0					0				
Apr-32		0.28	0	0					0						0					0	6599		0					0				
May-32	0.195	0.28	314	4950	11107	7735	4950	1534	1534	1403	977	0	0	0	1849	0.174	4890	3039	3039	0	5409	434	434	165	103	103	32	364	0				
Jun-32	0.291	0.28	4948	14999	11107	11543	11543	4653	8189	1403	1458	1458	1458	452	12050	0.264	4890	4611	4611	1649	11200	963	2612	165	156	156	70	2527	0				
Jul-32	0.515	0.28	2939	11914	11107	20429	11914	6658	6658	1403	2581	2447	2447	1075	8226	0.471	4890	8226	8226	0	11200	1768	1768	165	278	278	129	1619	0				
Aug-32	0.489	0.50	959	1457	11107	9086	1457	3950	3950	1403	1148	1148	1148	896	4658	0.354	4890	3462	3462	1196	11200	1340	2536	165	117	117	98	2517	0	19337	0		
Sep-32	0.171	0.50	515	0	11107	3799	8	1312	1312	1403	480	480	480	484	1831					1831	11200	576	2408				42	2450					
Oct-32		0.50	141	0				87	88					136	365					365	11200	96	461				7	468					
Nov-32			30	1				0	1					29	59					59	11200		59				0	59					
Dec-32			0	0					0						0					0	11200		0					0				
Jan-33			0	0					0						0					0	11200		0					0				
Feb-33			0	4					4						4					0	11200		0					0				
Mar-33			0	0					0						0					4	11200		4					4				
Apr-33		0.28	0	0					0						0					0	11200		0					0				
May-33	0.195	0.28	314	3889	11107	7735	3889	1206	1206	1403	977	0	0	0	1520	0.174	4890	3039	3039	0	9681	434	434	165	103	103	32	364	0				
Jun-33	0.291	0.28	689	2568	11107	11543	2568	1637	1637	1403	1458	0	0	0	2326	0.264	4890	4611	4611	0	7397	963	963	165	156	156	70	878	0				
Jul-33	0.515	0.28	1252	5874	11107	20429	5874	2738	2738	1403	2581	0	0	0	3990	0.471	4890	8226	8226	0	3161	1768	1768	165	278	278	129	1619	0				
Aug-33	0.489	0.50	959	1123	11107	9086	1123	1737	1737	1403	1148	0	0	0	2697	0.354	4890	3462	3462	0	2395	1340	1340	165	117	117	98	1321	0	19337	0		
Sep-33	0.171	0.50	515	0	11107	3799	0	703	703	1403	480	0	0	0	1218					0	3614	576	576				42	618					
Oct-33		0.50	141	0				67	68					0	289					0	3823	96	96				7	103					
Nov-33			30	1				0	1					0	30					0	3853		0				0	0				
Dec-33			0	0					0						0					0	3853		0					0				
Jan-34			0	0					0						0					0	3854		0					0				
Feb-34			0	4					4						4					0	3857		0					0				
Mar-34			0	270					270						270					0	4127		0					0				
Apr-34		0.28	0	0					0						0					0	4128		0					0				
May-34	0.195	0.28	314	3885	11107	7735	3885	1204	1204	1403	977	0	0	0	1518	0.174	4890	3039	3039	0	2687	434	434	165	103	103	32	364	0				
Jun-34	0.291	0.28	689	2404	11107	11543	2404	1588	1588	1403	1458	0	0	0	2277	0.264	4890	4611	4611	0	274	963	963	165	156	156	70	878	0				
Jul-34	0.515	0.28	1252	5818	11107	20429	5810	2684	2684	1403	2581	0	0	0	3936	0.471	4890	8226	4210	0	0	1194	1194	165	278	278	129	1045	0				
Aug-34	0.489	0.50	956	1123	11107	9086	1123	1709	1709	1403	1148	0	0	0	2665	0.354	4890	3462	2665	0	0	865	865	165	117	117	98	846	0	14525	4813		

Petrolia Normal Storage (AF) = 11220 , Dead Storage = 0

(A) Date	(B) NIR Above Petrolia	(C) Eff Above Petrolia	(D) yw Cr Entering Petrolia	(E) Fw Cr Above Petrolia	(F) Pre 1950 Acres Abv Petrolia	(G) Pre 1950 Desired Diversion	(H) Pre 1950 Actual Diversion	(I) Return Flow	(J) Stream Flow	(K) Post 1950 Acres Abv Petrolia	(L) Post 1950 Desired Diversion	(M) Available Flow After Pet Rights	(N) Post 1950 Actual Diversion	(O) Return Flow	(P) Petrolia Reservoir Inflow	(Q) NIR Below Petrolia	(R) Pet 1950 Acres Below Res	(S) Pet 1950 Desired Diversion	(T) Pet 1950 Actual Diversion	(U) Spilled Flow	(V) Petrolia Res EOM Storage	(W) Pet. 1950 Return Flow	(X) Stream Flow	(Y) Pre 1950 Damscheo Acres	(Z) Damscheo Desired Diversion	(AA) Damscheo Actual Diversion	(AB) Damscheo Return Flow	(AC) Stream Flow	(AD) Pre 1950 Damscheo Shortage	(AE) Pet. 1950 Total Ann. Diversion	(AF) Pet. 1950 Total Ann Shortage	(AG) Weibull Plotting Position	(AH) Sorted Pet Ann Yields
Sep-34	0.171	0.50	434	0	11107	3799	0	696	698	1483	480	0	0	2	1131					0	1131	353	353				42	395					
Oct-34		0.50	85	0				67	68					0	153					0	1284	74	74				7	81					
Nov-34			6	1				0	1					0	7					0	1291		0				0	0					
Dec-34			0	0					0						0					0	1291		0					0				
Jan-35			0	0					0						0					0	1291		0					0				
Feb-35			0	4					4						4					0	1295		0					0				
Mar-35			0	0					0						0					0	1295		0					0				
Apr-35		0.28	0	0					0						0					0	1295		0					0				
May-35	0.195	0.28	314	3889	11107	7735	3889	1206	1206	1483	977	0	0	0	1520	0.174	4890	3039	2815	0	0	402	402	165	103	103	32	332	0				
Jun-35	0.291	0.28	623	2508	11107	11543	2568	1637	1637	1483	1458	0	0	0	2260	0.264	4890	4611	2268	0	0	685	685	165	156	156	70	528	0				
Jul-35	0.515	0.28	1021	5674	11107	20429	5874	2736	2736	1483	2581	0	0	0	3759	0.471	4890	8226	3759	0	0	884	884	165	278	278	129	736	0				
Aug-35	0.489	0.50	653	1123	11107	9886	1123	1737	1737	1483	1148	0	0	0	2391	0.354	4890	3462	2391	0	0	694	694	165	117	117	98	675	0	11224	8113		
Sep-35	0.171	0.50	271	0	11107	3799	0	703	703	1483	460	0	0	0	974					0	974	316	316				42	358					
Oct-35		0.50	39	0				67	68					0	107					0	1081	66	66				7	73					
Nov-35			6	1				0	1					0	7					0	1088		0				0	0				
Dec-35			0	0					0						0					0	1088		0					0				
Jan-36			0	0					0						0					0	1088		0					0				
Feb-36			0	4					4						4					0	1092		0					0				
Mar-36			0	75					75						75					0	1167		0					0				
Apr-36		0.28	0	8					8						8					0	1175		0					0				
May-36	0.195	0.28	314	3892	11107	7735	3892	1207	1207	1483	977	0	0	0	1521	0.174	4890	3039	2696	0	-0	385	385	165	103	103	32	315	0				
Jun-36	0.291	0.28	612	2388	11107	11543	2388	1585	1585	1483	1458	0	0	0	2196	0.264	4890	4611	2196	0	-0	584	584	165	156	156	70	499	0				
Jul-36	0.515	0.28	1005	5810	11107	20429	5810	2681	2681	1483	2581	0	0	0	3686	0.471	4890	8226	3686	0	-0	862	862	165	278	278	129	714	0				
Aug-36	0.489	0.50	644	1123	11107	9886	1123	1707	1707	1483	1148	0	0	0	2352	0.354	4890	3462	2352	0	-0	680	680	165	117	117	98	661	0	10929	8488		
Sep-36	0.171	0.50	268	0	11107	3799	0	698	698	1483	480	0	0	0	966					0	966	310	310				42	352					
Oct-36		0.50	39	0				67	68					0	107					0	1073	65	65				7	72					
Nov-36			6	1				0	1					0	7					0	1079		0				0	0				
Dec-36			0	0					0						0					0	1080		0					0				
Jan-37			0	0					0						0					0	1080		0					0				
Feb-37			0	4					4						4					0	1084		0					0				
Mar-37			0	0					0						0					0	1084		0					0				
Apr-37		0.28	0	0					0						0					0	1084		0					0				
May-37	0.195	0.28	314	3885	11107	7735	3885	1204	1204	1483	977	0	0	0	1518	0.174	4890	3039	2602	0	-0	372	372	165	103	103	32	301	0				
Jun-37	0.291	0.28	600	2387	11107	11543	2387	1583	1583	1483	1458	0	0	0	2183	0.264	4890	4611	2183	0	-0	572	572	165	156	156	70	487	0				
Jul-37	0.515	0.28	996	5810	11107	20429	5810	2680	2680	1483	2581	0	0	0	3677	0.471	4890	8226	3677	0	-0	856	856	165	278	278	129	707	0				
Aug-37	0.489	0.50	641	1123	11107	9886	1123	1707	1707	1483	1148	0	0	0	2348	0.354	4890	3462	2348	0	-0	678	678	165	117	117	98	659	0	10810	8527		
Sep-37	0.171	0.50	268	0	11107	3799	0	698	698	1483	480	0	0	0	966					0	966	309	309				42	351					
Oct-37		0.50	39	0				67	68					0	107					0	1073	65	65				7	72					
Nov-37			6	1				0	1					0	7					0	1079		0				0	0				
Dec-37			0	0					0						0					0	1080		0					0				
Jan-38			0	0					0						0					0	1080		0					0				
Feb-38			0	4					4						4					0	1084		0					0				
Mar-38			0	0					0						0					0	1084		0					0				
Apr-38		0.28	0	0					0						0					0	1084		0					0				
May-38	0.195	0.28	314	3912	11107	7735	3912	1213	1213	1483	977	0	0	0	1527	0.174	4890	3039	2611	0	0	373	373	165	103	103	32	302	0				
Jun-38	0.291	0.28	689	3892	11107	11543	3892	1807	1807	1483	1458	0	0	0	2496	0.264	4890	4611	2496	0	0	618	618	165	156	156	70	533	0				
Jul-38	0.515	0.28	1226	7872	11107	20429	7872	3227	3227	1483	2581	0	0	0	4453	0.471	4890	8226	4453	0	0	998	998	165	278	278	129	850	0				
Aug-38	0.489	0.50	787	1158	11107	9886	1160	2054	2054	1483	1148	0	0	0	2841	0.354	4890	3462	2841	0	0	815	815	165	117	117	98	796	0	12401	6936		
Sep-38	0.171	0.50	321	0	11107	3799	0	829	828	1483	480	0	0	0	1141					0	1141	374	374				42	417					
Oct-38		0.50	48	0				78	78					0	119					0	1258	79	79				7	86					
Nov-38			6	1				0	1					0	7					0	1257		0				0	0				

Petrolia Normal Storage (AF) = 11200 , Dead Storage = 0

(A) Date	(B) NIF Above Petrolia	(C) Evt Above Petrolia	(D) WW Cr Entering Petrolia	(E) FW Cr Above Petrolia	(F) Pre 1950 Acres Abv Petrolia	(G) Pre 1950 Desired Diversion	(H) Pre 1950 Actual Diversion	(I) Return Flow	(J) Stream Flow	(K) Post 1950 Acres Abv Petrolia	(L) Post 1950 Desired Diversion	(M) Available Flow After Pet Rights	(N) Post 1950 Actual Diversion	(O) Return Flow	(P) Petrolia Reservoir Inflow	(Q) NIF Below Petrolia	(R) Pet 1950 Acres Below Res	(S) Pet 1950 Desired Diversion	(T) Pet 1950 Actual Diversion	(U) Spilled Flow	(V) Petrolia Res EOM Storage	(W) Pet. 1950 Return Flow	(X) Stream Flow	(Y) Pre 1950 Damschen Acres	(Z) Damschen Desired Diversion	(AA) Damschen Actual Diversion	(AB) Damschen Return Flow	(AC) Stream Flow	(AD) Pre 1950 Damschen Shortage	(AE) Pet. 1950 Total Ann. Diversion	(AF) Pet. 1950 Total Ann Shortage	(AG) Weibull Plotting Position	(AH) Sorted Pet Ann Yields
Dec-38			0	139					139						139					0	1396		0					0					
Jan-39			0	123					123						123					0	1519		0					0					
Feb-39			0	164					164						164					0	1683		0					0					
Mar-39			0	814					814						814					0	2497		0					0					
Apr-39		0.28	0	91					91						91					0	2587		0					0					
May-39	0.195	0.28	314	4035	11107	7735	4035	1251	1251	1403	977	0	0	0	1565	0.174	4898	3039	3039	0	1114	434	434	165	103	103	32	364	0				
Jun-39	0.291	0.28	685	4214	11107	11543	4214	2162	2162	1403	1458	0	0	0	2871	0.264	4898	4611	3984	0	0	874	874	165	156	156	78	789	0				
Jul-39	0.515	0.28	1252	6247	11107	20429	6247	3226	3226	1403	2581	0	0	0	4478	0.471	4898	8226	4478	0	0	1169	1169	165	278	278	129	1821	0				
Aug-39	0.409	0.50	958	1125	11107	9886	1125	1972	1972	1403	1148	0	0	0	2903	0.354	4898	3462	2903	0	0	887	887	165	117	117	98	868	0	14484	4933		
Sep-39	0.171	0.50	410	0	11107	3799	0	738	738	1403	480	0	0	0	1154					0	1154	379	379				42	422					
Oct-39		0.50	77	0				67	68					0	145					0	1299	80	80				7	87					
Nov-39			6	1				0	1					0	7					0	1306		0				0	0					
Dec-39			0	74					74						74					0	1380		0					0					
Jan-40			0	66					66						66					0	1446		0					0					
Feb-40			0	215					215						215					0	1660		0					0					
Mar-40			0	382					382						382					0	2042		0					0					
Apr-40		0.28	0	3					3						3					0	2045		0					0					
May-40	0.195	0.28	314	3912	11107	7735	3912	1213	1213	1403	977	0	0	0	1527	0.174	4898	3039	3039	0	533	434	434	165	103	103	32	364	0				
Jun-40	0.291	0.28	685	2530	11107	11543	2530	1630	1630	1403	1458	0	0	0	2319	0.264	4898	4611	2852	0	0	712	712	165	156	156	78	627	0				
Jul-40	0.515	0.28	1685	5810	11107	20429	5810	2712	2712	1403	2581	0	0	0	3796	0.471	4898	8226	3796	0	0	958	958	165	278	278	129	810	0				
Aug-40	0.409	0.50	686	1123	11107	9886	1123	1728	1728	1403	1148	0	0	0	2405	0.354	4898	3462	2405	0	0	724	724	165	117	117	98	705	0	12092	7245		
Sep-40	0.171	0.50	276	0	11107	3799	0	696	698	1403	480	0	0	0	974					0	974	318	318				42	360					
Oct-40		0.50	39	0				67	68					0	107					0	1080	67	67				7	74					
Nov-40			6	1				0	1					0	7					0	1087		0				0	0					
Dec-40			0	0					0						0					0	1087		0					0					
Jan-41			0	0					0						0					0	1088		0					0					
Feb-41			0	4					4						4					0	1091		0					0					
Mar-41			0	0					0						0					0	1092		0					0					
Apr-41		0.28	0	0					0						0					0	1092		0					0					
May-41	0.195	0.28	314	3886	11107	7735	3886	1205	1205	1403	977	0	0	0	1519	0.174	4898	3039	2610	0	-0	373	373	165	103	103	32	302	0				
Jun-41	0.291	0.28	634	2652	11107	11543	2652	1665	1665	1403	1458	0	0	0	2299	0.264	4898	4611	2299	0	-0	590	590	165	156	156	78	595	0				
Jul-41	0.515	0.28	1058	6842	11107	20429	6842	2810	2810	1403	2581	0	0	0	3868	0.471	4898	8226	3868	0	-0	894	894	165	278	278	129	746	0				
Aug-41	0.409	0.50	705	1519	11107	9886	1519	1861	1861	1403	1148	0	0	0	2566	0.354	4898	3462	2566	0	-0	722	722	165	117	117	98	703	0	11336	8002		
Sep-41	0.171	0.50	300	0	11107	3799	0	775	775	1403	480	0	0	0	1075					0	1075	331	331				42	373					
Oct-41		0.50	49	1				91	92					0	141					0	1216	71	71				7	78					
Nov-41			6	16				0	16					0	17					0	1232		0				0	0					
Dec-41			0	825					825						825					0	2058		0					0					
Jan-42			0	651					651						651					0	2709		0					0					
Feb-42			0	571					571						571					0	3279		0					0					
Mar-42			0	674					674						674					0	3953		0					0					
Apr-42		0.28	0	3732					3732						3732					0	7685		0					0					
May-42	0.195	0.28	314	6665	11107	7735	6665	2066	2066	1403	977	0	0	0	2380	0.174	4898	3039	3039	0	7027	434	434	165	103	103	32	364	0				
Jun-42	0.291	0.28	2979	10489	11107	11543	10489	4698	4698	1403	1458	0	0	0	7677	0.264	4898	4611	4611	0	10894	963	963	165	156	156	78	878	0				
Jul-42	0.515	0.28	1252	6881	11107	20429	6881	5004	5004	1403	2581	0	0	0	6256	0.471	4898	8226	8226	0	8124	1768	1768	165	278	278	129	1619	0				
Aug-42	0.409	0.50	959	1739	11107	9886	1739	2799	2799	1403	1148	0	0	0	3759	0.354	4898	3462	3462	0	8421	1340	1340	165	117	117	98	1321	0	19337	0		
Sep-42	0.171	0.50	515	118	11107	3799	118	900	900	1403	480	0	0	0	1415					0	9835	576	576				42	618					
Oct-42		0.50	141	0				121	121					0	262					0	10098	96	96				7	103					
Nov-42			30	1				7	8					0	38					0	10135		0				0	0					
Dec-42			0	439					439						439					0	16574		0					0					
Jan-43			0	499					499						499					0	11074		0					0					
Feb-43			0	1153					1153						1153					1027	11200		1027					1027					

Petrolia Normal Storage (AF) = 11200 , Dead Storage = 0

(A) Date	(B) NIR Above Petrolia	(C) Eff Above Petrolia	(D) YW Cr Entering Petrolia	(E) FW Cr Above Petrolia	(F) Pre 1950 Acres Ab Petrolia	(G) Pre 1950 Desired Diversion	(H) Pre 1950 Actual Diversion	(I) Return Flow	(J) Stream Flow	(K) Post 1950 Acres Abv Petrolia	(L) Post 1950 Desired Diversion	(M) Available Flow After Pet Rights	(N) Post 1950 Actual Diversion	(O) Return Flow	(P) Petrolia Reservoir Inflow	(Q) NIR Below Petrolia	(R) Pet 1950 Acres Below Res	(S) Pet 1950 Desired Diversion	(T) Pet 1950 Actual Diversion	(U) Spilled Flow	(V) Petrolia Res EOM Storage	(W) Pet. 1950 Return Flow	(X) Stream Flow	(Y) Pre 1950 Danschen Acres	(Z) Danschen Desired Diversion	(AA) Danschen Actual Diversion	(AB) Danschen Return Flow	(AC) Stream Flow	(AD) Pre 1950 Danschen Shortage	(AE) Pet. 1950 Total Ann. Diversion	(AF) Pet. 1950 Total Ann Shortage	(AG) Weibull Plotting Position	(AH) Sorted Pet Ann Yields
Mar-43			651	1978					1978						2630					2630	11200		2630					2630					
Apr-43		0.28	237	574					574						811					811	11200		811					811					
May-43	0.195	0.28	807	4295	11107	7735	4295	1331	1331	1403	977	0	0	0	2138	0.174	4890	3039	3039	0	10299	434	434	165	103	103	32	364	0				
Jun-43	0.291	0.28	3260	10642	11107	11543	10642	4231	4231	1403	1458	1458	1458	452	6485	0.264	4890	4611	4611	973	11200	963	1937	165	156	156	70	1851	0				
Jul-43	0.515	0.28	1252	7472	11107	20429	7472	5825	5825	1403	2581	0	0	316	6593	0.471	4890	8226	8226	0	9568	1768	1768	165	278	278	129	1619	0				
Aug-43	0.409	0.50	959	1538	11107	9086	1538	2919	2919	1403	1148	0	0	136	4014	0.354	4890	3462	3462	0	10119	1340	1340	165	117	117	98	1321	0	19337	0		
Sep-43	0.171	0.50	515	0	11107	3799	0	910	910	1403	480	431	431	86	1081					0	11200	576	576				42	618					
Oct-43		0.50	141	0				92	93					60	294					294	11200	96	390				7	397					
Nov-43			30	1				0	1					26	56					56	11200		56				0	56					
Dec-43			0	365					365						365					365	11200		365					365					
Jan-44			0	286					286						286					286	11200		286					286					
Feb-44			0	333					333						333					333	11200		333					333					
Mar-44			0	788					788						788					788	11200		788					788					
Apr-44		0.28	0	71					71						71					71	11200		71					71					
May-44	0.195	0.28	512	3945	11107	7735	3945	1223	1223	1403	977	0	0	0	1735	0.174	4890	3039	3039	0	9097	434	434	165	103	103	32	364	0				
Jun-44	0.291	0.28	1084	5382	11107	11543	5382	2525	2525	1403	1458	0	0	0	3608	0.264	4890	4611	4611	0	8895	963	963	165	156	156	70	878	0				
Jul-44	0.515	0.28	1252	7051	11107	20429	7051	3721	3721	1403	2581	0	0	0	4973	0.471	4890	8226	8226	0	5642	1768	1768	165	278	278	129	1619	0				
Aug-44	0.409	0.50	959	1451	11107	9086	1491	2329	2329	1403	1148	0	0	0	3288	0.354	4890	3462	3462	0	5468	1340	1340	165	117	117	98	1321	0	19337	0		
Sep-44	0.171	0.50	515	0	11107	3799	0	864	864	1403	480	0	0	0	1379					0	6047	576	576				42	618					
Oct-44		0.50	141	0				89	90					0	231					0	7078	96	96				7	103					
Nov-44			30	1				0	1					0	30					0	7108		0				0	0					
Dec-44			0	296					296						296					0	7405		0					0					
Jan-45			0	269					269						269					0	7673		0					0					
Feb-45			0	224					224						224					0	7898		0					0					
Mar-45			0	373					373						373					0	8270		0					0					
Apr-45		0.28	0	2					2						2					0	8273		0					0					
May-45	0.195	0.28	314	3922	11107	7735	3922	1216	1216	1403	977	0	0	0	1530	0.174	4890	3039	3039	0	6764	434	434	165	103	103	32	364	0				
Jun-45	0.291	0.28	689	4070	11107	11543	4070	2113	2113	1403	1458	0	0	0	2802	0.264	4890	4611	4611	0	4955	963	963	165	156	156	70	878	0				
Jul-45	0.515	0.28	1252	6022	11107	20429	6022	3115	3115	1403	2581	0	0	0	4367	0.471	4890	8226	8226	0	1096	1768	1768	165	278	278	129	1619	0				
Aug-45	0.409	0.50	959	1125	11107	9086	1125	1910	1910	1403	1148	0	0	0	2870	0.354	4890	3462	3462	0	504	1340	1340	165	117	117	98	1321	0	19337	0		
Sep-45	0.171	0.50	515	0	11107	3799	0	718	718	1403	480	0	0	0	1233					0	1737	576	576				42	618					
Oct-45		0.50	141	0				68	68					0	209					0	1946	96	96				7	103					
Nov-45			30	1				0	1					0	30					0	1976		0				0	0					
Dec-45			0	134					134						134					0	2110		0					0					
Jan-46			0	305					305						305					0	2416		0					0					
Feb-46			0	302					302						302					0	2717		0					0					
Mar-46			0	405					405						405					0	3123		0					0					
Apr-46		0.28	0	4					4						4					0	3127		0					0					
May-46	0.195	0.28	314	3947	11107	7735	3947	1224	1224	1403	977	0	0	0	1538	0.174	4890	3039	3039	0	1626	434	434	165	103	103	32	364	0				
Jun-46	0.291	0.28	689	3167	11107	11543	3167	1838	1838	1403	1458	0	0	0	2527	0.264	4890	4611	4152	0	0	898	898	165	156	156	70	813	0				
Jul-46	0.515	0.28	1252	5914	11107	20429	5914	2888	2888	1403	2581	0	0	0	4139	0.471	4890	8226	4139	0	0	1138	1138	165	278	278	129	989	0				
Aug-46	0.409	0.50	959	1123	11107	9086	1123	1802	1802	1403	1148	0	0	0	2762	0.354	4890	3462	2762	0	-0	847	847	165	117	117	98	828	0	14092	5245		
Sep-46	0.171	0.50	515	0	11107	3799	0	707	707	1403	480	0	0	0	1222					0	1222	356	356				42	398					
Oct-46		0.50	141	0				67	68					0	209					0	1431	76	76				7	83					
Nov-46			30	1				0	1					0	30					0	1462		0				0	0					
Dec-46			0	178					178						178					0	1640		0					0					
Jan-47			0	151					151						151					0	1790		0					0					
Feb-47			0	270					270						270					0	2060		0					0					
Mar-47			0	1761					1761						1761					0	3821		0					0					
Apr-47		0.28	0	3835					3835						3835					0	7656		0					0					
May-47	0.195	0.28	314	4129	11107	7735	4129	1280	1280	1403	977	0	0	0	1594	0.174	4890	3039	3039	0	6211	434	434	165	103	103	32	364	0				

Petrolia Normal Storage (AF) = 11200 , Dead Storage = 0

(A) Date	(B) NIR Above Petrolia	(C) Eff Above Petrolia	(D) YW Cr Entering Petrolia	(E) FW Cr Above Petrolia	(F) Pre 1950 Acres Abv Petrolia	(G) Pre 1950 Desired Diversion	(H) Pre 1950 Actual Diversion	(I) Return Flow	(J) Stream Flow	(K) Post 1950 Acres Abv Petrolia	(L) Post 1950 Desired Diversion	(M) Available Flow After Pet Rights	(N) Post 1950 Actual Diversion	(O) Return Flow	(P) Petrolia Reservoir Inflow	(Q) NIR Below Petrolia	(R) Pet 1950 Acres Below Res	(S) Pet 1950 Desired Diversion	(T) Pet 1950 Actual Diversion	(U) Spilled Flow	(V) Petrolia Res EOM Storage	(W) Pet. 1950 Return Flow	(X) Stream Flow	(Y) Pre 1950 Damscheo Acres	(Z) Damscheo Desired Diversion	(AA) Damscheo Actual Diversion	(AB) Damscheo Return Flow	(AC) Stream Flow	(AD) Pre 1950 Damscheo Shortage	(AE) Pet. 1950 Total Ano. Diversion	(AF) Pet. 1950 Total Ano Shortage	(AG) Weibull Plotting Position	(AH) Sorted Pet Ann Yields
Jun-47	0.291	0.28	689	3831	11107	11543	3841	2887	2887	1403	1458	0	0	0	2776	0.264	4890	4611	4611	0	4376	963	963	165	156	156	70	878	0				
Jul-47	0.515	0.28	1252	5950	11107	20429	5950	3862	3862	1403	2581	0	0	0	4314	0.471	4890	8226	8226	0	464	1768	1768	165	278	278	129	1619	0				
Aug-47	0.409	0.50	959	1131	11107	9086	1131	1875	1875	1403	1148	0	0	0	2634	0.354	4890	3462	3298	0	0	1325	1325	165	117	117	98	1306	0	19173	164		
Sep-47	0.171	0.50	515	0	11107	3799	0	712	712	1403	480	0	0	0	1227					0	1227	566	566				42	608					
Oct-47		0.50	141	0				68	68					0	209					0	1436	91	91				7	98					
Nov-47			30	1				0	1					0	30					0	1467		0				0	0					
Dec-47			0	143					143						143					0	1610		0					0				
Jan-48			0	221					221						221					0	1831		0					0				
Feb-48			0	240					240						240					0	2071		0					0				
Mar-48			0	479					479						479					0	2550		0					0				
Apr-48		0.28	0	58					58						58					0	2608		0					0				
May-48	0.195	0.28	314	4738	11107	7735	4738	1469	1469	1403	977	0	0	0	1783	0.174	4890	3039	3039	0	1352	434	434	165	103	103	32	364	0				
Jun-48	0.291	0.28	2531	10390	11107	11543	10390	4249	4249	1403	1458	0	0	0	6780	0.264	4890	4611	4611	0	3521	963	963	165	156	156	70	878	0				
Jul-48	0.515	0.28	3103	12308	11107	20429	12308	6511	6511	1403	2581	0	0	0	9613	0.471	4890	8226	8226	0	4909	1760	1768	165	278	278	129	1619	0				
Aug-48	0.409	0.50	959	1663	11107	9086	1683	3974	3974	1403	1148	0	0	0	4933	0.354	4890	3462	3462	0	6388	1340	1340	165	117	117	98	1321	0	19337	0		
Sep-48	0.171	0.50	515	0	11107	3799	0	1380	1380	1403	480	0	0	0	1895					0	8275	576	576				42	618					
Oct-48		0.50	141	0				101	101					0	242					0	8518	96	96				7	103					
Nov-48			30	99				0	99					0	129					0	8647		0				0	0				
Dec-48			0	185					185						185					0	8832		0					0				
Jan-49			0	140					140						140					0	8971		0					0				
Feb-49			0	580					580						586					0	9551		0					0				
Mar-49			1029	3394					3394						4421					2772	11200		2772					2772				
Apr-49		0.28	158	386					386						545					545	11200		545					545				
Mar-49	0.195	0.28	796	4270	11107	7735	4270	1324	1324	1403	977	0	0	0	2120	0.174	4890	3039	3039	0	10281	434	434	165	103	103	32	364	0				
Jun-49	0.291	0.28	986	4953	11107	11543	4953	2462	2462	1403	1458	0	0	0	3368	0.264	4890	4611	4611	0	9039	963	963	165	156	156	70	878	0				
Jul-49	0.515	0.28	1468	8326	11107	20429	8326	4053	4053	1403	2581	0	0	0	5521	0.471	4890	8226	8226	0	6335	1768	1768	165	278	278	129	1619	0				
Aug-49	0.409	0.50	959	1353	11107	9086	1353	2538	2538	1403	1148	0	0	0	3497	0.354	4890	3462	3462	0	6370	1340	1340	165	117	117	98	1321	0	19337	0		
Sep-49	0.171	0.50	515	0	11107	3799	0	964	964	1403	480	0	0	0	1479					0	7849	576	576				42	618					
Oct-49		0.50	141	8				81	82					0	223					0	8071	96	96				7	103					
Nov-49			30	0				0	0					0	30					0	8102		0				0	0				
Dec-49			0	0					0						0					0	8102		0					0				
Jan-50			0	0					0						0					0	8102		0					0				
Feb-50			0	23					23						23					0	8125		0					0				
Mar-50			0	847					847						847					0	8972		0					0				
Apr-50		0.28	0	562					562						562					0	9534		0					0				
Mar-50	0.195	0.28	454	4252	11107	7735	4252	1318	1318	1403	977	0	0	0	1772	0.174	4890	3039	3039	0	8266	434	434	165	103	103	32	364	0				
Jun-50	0.291	0.28	1024	5237	11107	11543	5237	2546	2546	1403	1458	0	0	0	3570	0.264	4890	4611	4611	0	7226	963	963	165	156	156	70	878	0				
Jul-50	0.515	0.28	1626	8706	11107	20429	8706	4231	4231	1403	2581	0	0	0	5856	0.471	4890	8226	8226	0	4856	1768	1768	165	278	278	129	1619	0				
Aug-50	0.409	0.50	959	1378	11107	9086	1378	2652	2652	1403	1148	0	0	0	3611	0.354	4890	3462	3462	0	5005	1340	1340	165	117	117	98	1321	0	19337	0		
Sep-50	0.171	0.50	515	0	11107	3799	0	1003	1003	1403	480	0	0	0	1518					0	6523	576	576				42	618					
Oct-50		0.50	141	0				83	83					0	224					0	6747	96	96				7	103					
Nov-50			30	0				0	0					0	30					0	6777		0				0	0				
Dec-50			0	103					103						103					0	6881		0					0				
			0	126																													
			0	212																													
			0	1331																													
			283	1129																													

Total Damscheo Shortage (af)= 0
Firm Petrolia Yield (af) = 10810
80% Petrolia Yield (af) = 12401

Petrolia Normal Storage (AF) = 14400, Dead Storage = 0

(A) Date	(B) NIR Above Petrolia	(C) Eff Above Petrolia	(D) YW Cr Entering Petrolia	(E) FW Cr Above Petrolia	(F) Pre 1950 Acres Abv Petrolia	(G) Pre 1950 Desired Diversion	(H) Pre 1950 Actual Diversion	(I) Return Flow	(J) Stream Flow	(K) Post 1950 Acres Abv Petrolia	(L) Post 1950 Desired Diversion	(M) Available Flow After Pet Rights	(N) Post 1950 Actual Diversion	(O) Return Flow	(P) Petrolia Reservoir Inflow	(Q) NIR Below Petrolia	(R) Pet 1950 Acres Below Res	(S) Pet 1950 Desired Diversion	(T) Pet 1950 Actual Diversion	(U) Spilled Flow	(V) Petrolia Res ECM Storage	(W) Pet. 1950 Return Flow	(X) Stream Flow	(Y) Pre 1950 Damschen Acres	(Z) Damschen Desired Diversion	(AA) Damschen Actual Diversion	(AB) Damschen Return Flow	(AC) Stream Flow	(AD) Pre 1950 Damschen Shortage	(AE) Pet. 1950 Total Ann. Diversion	(AF) Pet. 1950 Total Ann Shortage	(AG) Weibull Plotting Position	(AH) Sorted Pet Ann Yields
																					14400												0.033	19337
Jan-22			334	886					886						1140					1140	14400		1140					1140				0.067	19337
Feb-22			232	568					568						791					791	14400		791					791				0.100	19337
Mar-22			2474	5981					5981						8455					8455	14400		8455					8455				0.133	19337
Apr-22		0.28	1393	3367					3367						4760					4760	14400		4760					4760				0.167	19337
May-22	0.195	0.28	2389	8119	11107	7735	7735	2398	2782	1403	977	977	977	303	4497	0.174	4898	3039	3039	1458	14400	434	1892	165	103	103	32	1822	0			0.200	19337
Jun-22	0.291	0.28	5653	16427	11107	11543	11543	5257	10141	1403	1458	1458	1458	664	15000	0.264	4898	4611	4611	10389	14400	963	11352	165	156	156	78	11267	0			0.233	19337
Jul-22	0.515	0.28	1411	8188	11107	20429	8188	5763	5763	1403	2501	0	0	407	7501	0.471	4898	8226	8226	0	13755	1768	1768	165	278	278	129	1619	0			0.267	19337
Aug-22	0.409	0.50	959	1214	11107	9086	1214	3893	3893	1403	1148	182	182	156	4107	0.354	4898	3462	3462	0	14400	1340	1340	165	117	117	98	1321	0	19337	0	0.300	19337
Sep-22	0.171	0.50	515	0	11107	3799	0	932	932	1403	488	488	488	116	1077					1077	14400	576	1653				42	1695				0.333	19337
Oct-22		0.50	141	0				73	73					73	288					288	14400	96	383				7	390				0.367	19337
Nov-22			30	605				0	605					29	664					664	14400		664				0	664				0.400	19337
Dec-22			0	827					827						827					827	14400		827					827				0.433	19337
Jan-23			0	941					941						941					941	14400		941					941				0.467	19337
Feb-23			274	672					672						946					946	14400		946					946				0.500	19337
Mar-23			500	1210					1210						1710					1710	14400		1710					1710				0.533	19337
Apr-23		0.28	879	2123					2123						3002					3002	14400		3002					3002				0.567	19337
May-23	0.195	0.28	1218	5290	11107	7735	5290	1640	1640	1403	977	0	0	0	2058	0.174	4898	3039	3039	0	14220	434	434	165	103	103	32	364	0			0.600	19337
Jun-23	0.291	0.28	8489	23281	11107	11543	11543	4726	16464	1403	1458	1458	1458	452	23947	0.264	4898	4611	4611	19156	14400	963	20120	165	156	156	78	20034	0			0.633	19337
Jul-23	0.515	0.28	9660	28126	11107	20429	20429	9330	17027	1403	2501	2501	2501	1116	25223	0.471	4898	8226	8226	16997	14400	1768	18764	165	278	278	129	18616	0			0.667	19173
Aug-23	0.409	0.50	2305	6346	11107	9086	6346	6776	6776	1403	1148	1148	1148	925	8859	0.354	4898	3462	3462	5397	14400	1340	6737	165	117	117	98	6718	0	19337	0	0.700	17725
Sep-23	0.171	0.50	1087	2568	11107	3799	2568	3302	3302	1403	488	488	488	497	4406					4406	14400	576	4982				42	5024				0.733	17292
Oct-23		0.50	1401	2913				740	3653					136	5190					5190	14400	96	5286				7	5293				0.767	14404
Nov-23			1131	2635				154	2789					29	3949					3949	14400		3949				0	3949				0.800	12401
Dec-23			862	2083					2083						2945					2945	14400		2945					2945				0.833	12092
Jan-24			695	1680					1680						2375					2375	14400		2375					2375				0.867	11336
Feb-24			556	1344					1344						1900					1900	14400		1900					1900				0.900	11224
Mar-24			1026	2480					2480						3506					3506	14400		3506					3506				0.933	10929
Apr-24		0.28	3364	8131					8131						11495					11495	14400		11495					11495				0.967	10010
May-24	0.195	0.28	3987	11983	11107	7735	7735	2398	6646	1403	977	977	977	303	9959	0.174	4898	3039	3039	6920	14400	434	7355	165	103	103	32	7284	0				
Jun-24	0.291	0.28	4347	13269	11107	11543	11543	5257	6982	1403	1458	1458	1458	664	10535	0.264	4898	4611	4611	5924	14400	963	6887	165	156	156	78	6802	0				
Jul-24	0.515	0.28	2365	10493	11107	20429	10493	6477	6477	1403	2501	1403	1403	867	8226	0.471	4898	8226	8226	0	14400	1768	1768	165	278	278	129	1619	0				
Aug-24	0.409	0.50	959	2314	11107	9086	2314	3813	3813	1403	1148	1148	1148	687	4312	0.354	4898	3462	3462	850	14400	1340	2190	165	117	117	98	2171	0	19337	0		
Sep-24	0.171	0.50	515	522	11107	3799	522	1404	1404	1403	488	488	488	395	1834					1834	14400	576	2410				42	2452					
Oct-24		0.50	141	312				212	524					136	801					801	14400	96	897				7	904					
Nov-24			194	1022				31	1053					29	1276					1276	14400		1276				0	1276					
Dec-24			512	1236					1236						1748					1748	14400		1748					1748					
Jan-25			428	1035					1035						1463					1463	14400		1463					1463					
Feb-25			500	1210					1210						1710					1710	14400		1710					1710					
Mar-25			1368	3306					3306						4674					4674	14400		4674					4674					
Apr-25		0.28	973	2352					2352						3325					3325	14400		3325					3325					
May-25	0.195	0.28	818	4323	11107	7735	4323	1340	1340	1403	977	0	0	0	2150	0.174	4898	3039	3039	0	13519	434	434	165	103	103	32	364	0				
Jun-25	0.291	0.28	1133	5500	11107	11543	5500	2643	2643	1403	1458	0	0	0	3776	0.264	4898	4611	4611	0	12685	963	963	165	156	156	78	878	0				
Jul-25	0.515	0.28	1252	7082	11107	20429	7082	3791	3791	1403	2501	0	0	0	5043	0.471	4898	8226	8226	0	9502	1768	1768	165	278	278	129	1619	0				
Aug-25	0.409	0.50	959	1139	11107	9086	1139	2276	2276	1403	1148	0	0	0	3235	0.354	4898	3462	3462	0	9275	1340	1340	165	117	117	98	1321	0	19337	0		
Sep-25	0.171	0.50	515	0	11107	3799	0	818	818	1403	488	0	0	0	1333					0	10609	576	576				42	618					
Oct-25		0.50	141	0				68	69					0	210					0	10818	96	96				7	103					
Nov-25			30	456				0	456					0	486					0	11304		0				0	0					
Dec-25			0	531					531						531					0	11835		0					0					
Jan-26			0	331					331						331					0	12166		0					0					
Feb-26			0	298					298						298					0	12464		0					0					

Petrolia Normal Storage (AF) = 14400 , Dead Storage = 0

(A) Date	(B) NIR Above Petrolia	(C) Eff Above Petrolia	(D) YW Cr Entering Petrolia	(E) FW Cr Above Petrolia	(F) Pre 1950 Acres Ab. Petrolia	(G) Pre 1950 Desired Diversion	(H) Pre 1950 Actual Diversion	(I) Return Flow	(J) Stream Flow	(K) Post 1950 Acres Abv Petrolia	(L) Post 1950 Desired Diversion	(M) Available Flow After Pet Rights	(N) Post 1950 Actual Diversion	(O) Return Flow	(P) Petrolia Reservoir Inflow	(Q) NIR Below Petrolia	(R) Pet 1950 Acres Below Res	(S) Pet 1950 Desired Diversion	(T) Pet 1950 Actual Diversion	(U) Spilled Flow	(V) Petrolia Res EOM Storage	(W) Pet. 1950 Return Flow	(X) Stream Flow	(Y) Pre 1950 Damschen Acres	(Z) Damschen Desired Diversion	(AA) Damschen Actual Diversion	(AB) Damschen Return Flow	(AC) Stream Flow	(AD) Pre 1950 Damschen Shortage	(AE) Pet. 1950 Total Ann. Diversion	(AF) Pet. 1950 Total Ann Shortage	(AG) Weibull Plotting Position	(AH) Sorted Pet Ann Yields
Mar-26			0	331					331						331					0	12795		0					0					
Apr-26		0.28	0	444					444						444					0	13238		0					0					
May-26	0.195	0.28	314	3471	11107	7735	3471	1076	1076	1403	977	0	0	0	1398	0.174	4090	3039	3039	0	11590	434	434	165	103	103	32	364	0				
Jun-26	0.291	0.28	689	4062	11107	11543	4062	2013	2013	1403	1458	0	0	0	2701	0.264	4090	4611	4611	0	9680	963	963	165	156	156	70	878	0				
Jul-26	0.515	0.28	1252	7098	11107	20429	7098	3405	3405	1403	2581	0	0	0	4657	0.471	4090	8226	8226	0	6111	1768	1768	165	278	278	129	1619	0				
Aug-26	0.409	0.52	959	1139	11107	9086	1139	2146	2146	1403	1148	0	0	0	3105	0.354	4090	3462	3462	0	5755	1340	1340	165	117	117	98	1321	0	19337	0		
Sep-26	0.171	0.50	515	0	11107	3799	0	820	820	1403	480	0	0	0	1335					0	7089	576	576				42	618					
Oct-26		0.50	141	588				68	656					0	797					0	7886	96	96				7	103					
Nov-26			30	0				0	0					0	30					0	7916		0				0	0					
Dec-26			0	289					289						289					0	8205		0					0					
Jan-27			0	202					202						202					0	8407		0					0					
Feb-27			0	181					181						181					0	8588		0					0					
Mar-27			662	3360					3360						4022					0	12611		0					0					
Apr-27		0.28	601	1451					1451						2052					263	14400		263					263					
May-27	0.195	0.28	8102	21929	11107	7735	7735	2398	16591	1403	977	977	977	383	24019	0.174	4090	3039	3039	20980	14400	434	21415	165	103	103	32	21344	0				
Jun-27	0.291	0.28	7433	20728	11107	11543	11543	5257	14441	1403	1458	1458	1458	664	21080	0.264	4090	4611	4611	16469	14400	963	17432	165	156	156	70	17347	0				
Jul-27	0.515	0.28	2278	10254	11107	20429	10454	6406	6406	1403	2581	1244	1244	793	8226	0.471	4090	8226	8226	0	14400	1768	1768	165	278	278	129	1619	0				
Aug-27	0.409	0.50	959	1525	11107	9086	1525	3686	3686	1403	1148	1148	1148	635	4133	0.354	4090	3462	3462	671	14400	1340	2011	165	117	117	98	1992	0	19337	0		
Sep-27	0.171	0.50	515	855	11107	3799	855	1395	1395	1403	480	480	480	372	1803					1803	14400	576	2379				42	2421					
Oct-27		0.50	141	688				235	924					136	1201					1201	14400	96	1296				7	1303					
Nov-27			509	1465				51	1517					29	2055					2055	14400		2055				0	2055					
Dec-27			584	1411					1411						1995					1995	14400		1995					1995					
Jan-28			508	1219					1219						1718					1718	14400		1710					1710					
Feb-28			417	1008					1008						1425					1425	14400		1425					1425					
Mar-28			890	2150					2150						3040					3040	14400		3040					3040					
Apr-28		0.28	940	2271					2271						3211					3211	14400		3211					3211					
May-28	0.195	0.28	1071	4934	11107	7735	4934	1530	1530	1403	977	0	0	0	2601	0.174	4090	3039	3039	0	13962	434	434	165	103	103	32	364	0				
Jun-28	0.291	0.28	689	4242	11107	11543	4242	2386	2386	1403	1458	0	0	0	3075	0.264	4090	4611	4611	0	12426	963	963	165	156	156	70	878	0				
Jul-28	0.515	0.28	1743	9848	11107	20429	9848	4184	4184	1403	2581	0	0	0	5928	0.471	4090	8226	8226	0	10128	1768	1768	165	278	278	129	1619	0				
Aug-28	0.409	0.50	959	1298	11107	9086	1298	2618	2618	1403	1148	0	0	0	3577	0.354	4090	3462	3462	0	10243	1340	1340	165	117	117	98	1321	0	19337	0		
Sep-28	0.171	0.50	515	86	11107	3799	86	1040	1040	1403	480	0	0	0	1555					0	11798	576	576				42	618					
Oct-28		0.50	141	0				90	90					0	231					0	12029	96	96				7	103					
Nov-28			30	343				5	348					0	378					0	12408		0				0	0					
Dec-28			0	470					470						470					0	12878		0					0					
Jan-29			0	413					413						413					0	13291		0					0					
Feb-29			0	373					373						373					0	13664		0					0					
Mar-29			1661	4704					4704						6365					5629	14400		5629					5629					
Apr-29		0.28	663	1458					1458						2061					2061	14400		2061					2061					
May-29	0.195	0.28	1513	6883	11107	7735	6883	1861	1861	1403	977	486	486	151	3039	0.174	4090	3039	3039	0	14400	434	434	165	103	103	32	364	0				
Jun-29	0.291	0.28	1953	7483	11107	11543	7483	3622	3622	1403	1458	1458	1458	557	4675	0.264	4090	4611	4611	64	14400	963	1027	165	156	156	70	942	0				
Jul-29	0.515	0.28	1252	7398	11107	20429	7398	4475	4475	1403	2581	0	0	362	6089	0.471	4090	8226	8226	0	12263	1768	1768	165	278	278	129	1619	0				
Aug-29	0.409	0.50	959	1139	11107	9086	1139	2529	2529	1403	1148	0	0	136	3624	0.354	4090	3462	3462	0	12425	1340	1340	165	117	117	98	1321	0	19337	0		
Sep-29	0.171	0.50	515	0	11107	3799	0	848	848	1403	480	0	0	0	1363					0	13788	576	576				42	618					
Oct-29		0.50	141	0				68	69					9	210					0	13998	96	96				7	103					
Nov-29			30	181				0	181					0	211					0	14208		0				0	0					
Dec-29			0	381					381						381					189	14400		189					189					
Jan-30			0	374					374						374					374	14400		374					374					
Feb-30			0	607					607						607					607	14400		607					607					
Mar-30			486	2271					2271						2757					2757	14400		2757					2757					
Apr-30		0.28	884	2137					2137						3021					3021	14400		3021					3021					
May-30	0.195	0.28	1172	5178	11107	7735	5178	1685	1685	1403	977	0	0	0	2777	0.174	4090	3039	3039	0	14139	434	434	165	103	103	32	364	0				

Petrolia Normal Storage (AF) = 14400 , Dead Storage = 0

(A) Date	(B) NIR Above Petrolia	(C) Eff Above Petrolia	(D) Ind Cr Entering Petrolia	(E) FW Cr Above Petrolia	(F) Pre 1950 Acres Abv Petrolia	(G) Pre 1950 Desired Diversion	(H) Pre 1950 Actual Diversion	(I) Return Flow	(J) Stream Flo	(K) Post 1950 Acres Abv Petrolia	(L) Post 1950 Desired Diversion	(M) Available Flow After Pet Rights	(N) Post 1950 Actual Diversion	(O) Return Flow	(P) Petrolia Reservoir Inflow	(Q) NIR Below Petrolia	(R) Pet 1950 Acres Below Res	(S) Pet 1950 Desired Diversion	(T) Pet 1950 Actual Diversion	(U) Spilled Flow	(V) Petrolia Res EOM Storage	(W1) Pet. 1950 Return Flow	(X) Stream Flow	(Y) Pre 1950 Damschen Acres	(Z) Damschen Desired Diversion	(AA) Damschen Actual Diversion	(AB) Damschen Return Flow	(AC) Stream Flow	(AD) Pre 1950 Damschen Shortage	(AE) Pet. 1950 Total Ann. Diversion	(AF) Pet. 1950 Total Ann Shortage	(AG) Weibull Plotting Position	(AH) Sorted Pet Ann Yields
Jun-30	0.291	0.28	810	4721	11107	11543	4721	2587	2587	1403	1458	0	0	0	3397	0.264	4890	4611	4611	0	12925	963	963	165	156	156	70	878	0				
Jul-30	0.515	0.28	1470	8330	11107	20429	8330	4088	4088	1403	2581	0	0	0	5558	0.471	4890	8226	8226	0	10258	1768	1768	165	278	278	129	1619	0				
Aug-30	0.409	0.50	959	1303	11107	9086	1303	2507	2507	1403	1148	0	0	0	3467	0.354	4890	3462	3462	0	10263	1340	1340	165	117	117	98	1321	0	19337	0		
Sep-30	0.171	0.50	515	21	11107	3799	21	961	961	1403	488	0	0	0	1476					0	11739	576	576				42	618					
Oct-30		0.50	141	0				81	81					0	222					0	11961	96	96				7	103					
Nov-30			30	0				1	2					0	31					0	11993		0				0	0					
Dec-30			0	241					241						241					0	12234		0					0				
Jan-31			0	687					687						687					0	12922		0					0				
Feb-31			0	653					653						653					0	13575		0					0				
Mar-31			0	359					359						359					0	13934		0					0				
Apr-31		0.28	0	41					41						41					0	13975		0					0				
May-31	0.195	0.28	538	3549	11107	7735	3949	1224	1224	1403	977	0	0	0	1762	0.174	4890	3039	3039	0	12699	434	434	165	103	103	32	364	0				
Jun-31	0.291	0.28	781	4651	11107	11543	4651	2299	2299	1403	1458	0	0	0	3080	0.264	4890	4611	4611	0	11168	963	963	165	156	156	70	878	0				
Jul-31	0.515	0.28	1351	8043	11107	20429	8043	3870	3870	1403	2581	0	0	0	5221	0.471	4890	8226	8226	0	8163	1768	1768	165	278	278	129	1619	0				
Aug-31	0.409	0.50	959	1303	11107	9086	1303	2439	2439	1403	1148	0	0	0	3398	0.354	4890	3462	3462	0	8899	1340	1340	165	117	117	98	1321	0	19337	0		
Sep-31	0.171	0.50	515	0	11107	3799	0	931	931	1403	488	0	0	0	1446					0	9545	576	576				42	618					
Oct-31		0.50	141	0				78	79					0	220					0	9764	96	96				7	103					
Nov-31			30	0				0	0					0	30					0	9794		0				0	0				
Dec-31			0	0					0						0					0	9795		0					0				
Jan-32			0	0					0						0					0	9795		0					0				
Feb-32			0	4					4						4					0	9799		0					0				
Mar-32			0	0					0						0					0	9799		0					0				
Apr-32		0.28	0	0					0						0					0	9799		0					0				
May-32	0.195	0.28	314	4950	11107	7735	4950	1534	1534	1403	977	0	0	0	1849	0.174	4890	3039	3039	0	8689	434	434	165	103	103	32	364	0				
Jun-32	0.291	0.28	4948	14999	11107	11543	11543	4653	8188	1403	1458	1458	1458	452	12058	0.264	4890	4611	4611	1649	14400	963	2612	165	156	156	70	2527	0				
Jul-32	0.515	0.28	2939	11914	11107	20429	11914	6658	6658	1403	2581	2447	2447	1075	8226	0.471	4890	8226	8226	0	14400	1768	1768	165	278	278	129	1619	0				
Aug-32	0.409	0.50	959	1457	11107	9086	1457	3950	3950	1403	1148	1145	1148	896	4658	0.354	4890	3462	3462	1196	14400	1340	2536	165	117	117	98	2517	0	19337	0		
Sep-32	0.171	0.50	515	0	11107	3799	0	1312	1312	1403	488	488	488	484	1831					1831	14400	576	2488				42	2450					
Oct-32		0.50	141	0				87	88					136	365					365	14400	96	461				7	468					
Nov-32			30	1				0	1					29	59					59	14400		59				0	59					
Dec-32			0	0					0						0					0	14400		0					0				
Jan-33			0	0					0						0					0	14400		0					0				
Feb-33			0	4					4						4					4	14400		4					4				
Mar-33			0	0					0						0					0	14400		0					0				
Apr-33		0.28	0	0					0						0					0	14400		0					0				
May-33	0.195	0.28	314	3889	11107	7735	3889	1206	1206	1403	977	0	0	0	1520	0.174	4890	3039	3039	0	12881	434	434	165	103	103	32	364	0				
Jun-33	0.291	0.28	689	2560	11107	11543	2560	1637	1637	1403	1458	0	0	0	2326	0.264	4890	4611	4611	0	10597	963	963	165	156	156	70	878	0				
Jul-33	0.515	0.28	1252	5874	11107	20429	5874	2738	2738	1403	2581	0	0	0	3998	0.471	4890	8226	8226	0	6361	1768	1768	165	278	278	129	1619	0				
Aug-33	0.409	0.50	959	1123	11107	9086	1123	1737	1737	1403	1148	0	0	0	2697	0.354	4890	3462	3462	0	5595	1340	1340	165	117	117	98	1321	0	19337	0		
Sep-33	0.171	0.50	515	0	11107	3799	0	783	783	1403	488	0	0	0	1218					0	6814	576	576				42	618					
Oct-33		0.50	141	0				67	68					0	209					0	7023	96	96				7	103					
Nov-33			30	1				0	1					0	30					0	7053		0				0	0				
Dec-33			0	0					0						0					0	7053		0					0				
Jan-34			0	0					0						0					0	7054		0					0				
Feb-34			0	4					4						4					0	7057		0					0				
Mar-34			8	270					270						270					0	7327		0					0				
Apr-34		0.28	0	0					0						0					0	7328		0					0				
May-34	0.195	0.28	314	3285	11107	7735	3285	1204	1204	1403	977	0	0	0	1518	0.174	4890	3039	3039	0	5807	434	434	165	103	103	32	364	0				
Jun-34	0.291	0.28	689	2404	11107	11543	2404	1588	1588	1403	1458	0	0	0	2277	0.264	4890	4611	4611	0	3474	963	963	165	156	156	70	878	0				
Jul-34	0.515	0.28	1252	5810	11107	20429	5810	2684	2684	1403	2581	0	0	0	3936	0.471	4890	8226	7410	0	-0	1651	1651	165	278	278	129	1583	0				
Aug-34	0.409	0.50	956	1123	11107	9086	1123	1709	1709	1403	1148	0	0	0	2665	0.354	4890	3462	2665	0	0	1185	1185	165	117	117	90	1166	0	17725	1613		

Petrolia Normal Storage (AF) = 14400 , Dead Storage = 0

(A) Date	(B) NIR Above Petrolia	(C) Eff Above Petrolia	(D) YW Cr Entering Petrolia	(E) FW Cr Above Petrolia	(F) Pre 1950 Acres Abv Petrolia	(G) Pre 1950 Desired Diversion	(H) Pre 1950 Actual Diversion	(I) Return Flow	(J) Stream Flow	(K) Post 1950 Acres Abv Petrolia	(L) Post 1950 Desired Diversion	(M) Available Flow After Pet Rights	(N) Post 1950 Actual Diversion	(O) Return Flow	(P) Petrolia Reservoir Inflow	(Q) NIR Below Petrolia	(R) Pet 1950 Acres Below Res	(S) Pet 1950 Desired Diversion	(T) Pet 1950 Actual Diversion	(U) Spilled Flow	(V) Petrolia Res EOM Storage	(W) Pet. 1950 Return Flow	(X) Stream Flow	(Y) Pre 1950 Danschen Acres	(Z) Danschen Desired Diversion	(AA) Danschen Actual Diversion	(AB) Danschen Return Flow	(AC) Stream Flow	(AD) Pre 1950 Danschen Shortage	(AE) Pet. 1950 Total Ann. Diversion	(AF) Pet. 1950 Total Ann Shortage	(AG) Weibull Plotting Position	(AH) Sorted Pet Ann Yields
Sep-34	0.171	0.50	434	0	11107	3799	0	698	698	1403	480	0	0	0	1131					0	1131	490	490				42	532					
Oct-34		0.50	85	0				67	68					0	153					0	1284	74					7	81					
Nov-34			6	1				0	1					0	7					0	1291		0				0	0					
Dec-34			0	0					0						0					0	1291		0					0				
Jan-35			0	0					0						0					0	1291		0					0				
Feb-35			0	4					4						4					0	1295		0					0				
Mar-35			0	0					0						0					0	1295		0					0				
Apr-35		0.28	0	0					0						0					0	1295		0					0				
May-35	0.195	0.28	314	3889	11107	7735	3889	1206	1206	1403	977	0	0	0	1520	0.174	4890	3039	2815	0	0	402	402	165	103	103	32	332	0				
Jun-35	0.291	0.28	623	2560	11107	11543	2560	1637	1637	1403	1458	0	0	0	2260	0.264	4890	4611	2260	0	0	605	605	165	156	156	70	520	0				
Jul-35	0.515	0.28	1021	5874	11107	20429	5874	2738	2738	1403	2581	0	0	0	3759	0.471	4890	8226	3759	0	0	884	884	165	278	278	129	736	0				
Aug-35	0.409	0.50	653	1123	11107	9886	1123	1737	1737	1403	1148	0	0	0	2391	0.354	4890	3462	2391	0	0	694	694	165	117	117	98	675	0	11224	8113		
Sep-35	0.171	0.50	271	0	11107	3799	0	703	703	1403	480	0	0	0	974					0	974	316	316				42	358					
Oct-35		0.50	39	0				67	68					0	107					0	1081	66	66				7	73					
Nov-35			6	1				0	1					0	7					0	1088		0				0	0				
Dec-35			0	0					0						0					0	1088		0					0				
Jan-36			0	0					0						0					0	1088		0					0				
Feb-36			0	4					4						4					0	1092		0					0				
Mar-36			0	75					75						75					0	1167		0					0				
Apr-36		0.28	0	8					8						8					0	1175		0					0				
May-36	0.195	0.28	314	3892	11107	7735	3892	1207	1207	1403	977	0	0	0	1521	0.174	4890	3039	2696	0	-0	385	385	165	103	103	32	315	0				
Jun-36	0.291	0.28	612	2388	11107	11543	2388	1585	1585	1403	1458	0	0	0	2196	0.264	4890	4611	2196	0	-0	584	584	165	156	156	70	499	0				
Jul-36	0.515	0.28	1005	5810	11107	20429	5810	2681	2681	1403	2581	0	0	0	3686	0.471	4890	8226	3686	0	-0	862	862	165	278	278	129	714	0				
Aug-36	0.409	0.50	644	1123	11107	9886	1123	1707	1707	1403	1148	0	0	0	2352	0.354	4890	3462	2352	0	-0	680	680	165	117	117	98	661	0	10929	8408		
Sep-36	0.171	0.50	268	0	11107	3799	0	698	698	1403	480	0	0	0	966					0	966	310	310				42	352					
Oct-36		0.50	39	0				67	68					0	107					0	1073	65	65				7	72					
Nov-36			6	1				0	1					0	7					0	1079		0				0	0				
Dec-36			0	0					0						0					0	1080		0					0				
Jan-37			0	0					0						0					0	1080		0					0				
Feb-37			0	4					4						4					0	1084		0					0				
Mar-37			0	0					0						0					0	1084		0					0				
Apr-37		0.28	0	0					0						0					0	1084		0					0				
May-37	0.195	0.28	314	3885	11107	7735	3885	1204	1204	1403	977	0	0	0	1518	0.174	4890	3039	2602	0	-0	372	372	165	103	103	32	301	0				
Jun-37	0.291	0.28	600	2387	11107	11543	2387	1583	1583	1403	1458	0	0	0	2183	0.264	4890	4611	2183	0	-0	572	572	165	156	156	70	487	0				
Jul-37	0.515	0.28	996	5810	11107	20429	5810	2680	2680	1403	2581	0	0	0	3677	0.471	4890	8226	3677	0	-0	856	856	165	278	278	129	707	0				
Aug-37	0.409	0.50	641	1123	11107	9886	1123	1707	1707	1403	1148	0	0	0	2348	0.354	4890	3462	2348	0	-0	678	678	165	117	117	98	659	0	10810	8527		
Sep-37	0.171	0.50	268	0	11107	3799	0	698	698	1403	480	0	0	0	966					0	966	309	309				42	351					
Oct-37		0.50	39	0				67	68					0	107					0	1073	65	65				7	72					
Nov-37			6	1				0	1					0	7					0	1079		0				0	0				
Dec-37			0	0					0						0					0	1080		0					0				
Jan-38			0	0					0						0					0	1080		0					0				
Feb-38			0	4					4						4					0	1084		0					0				
Mar-38			0	0					0						0					0	1084		0					0				
Apr-38		0.28	0	0					0						0					0	1084		0					0				
May-38	0.195	0.28	314	3912	11107	7735	3912	1213	1213	1403	977	0	0	0	1527	0.174	4890	3039	2611	0	0	373	373	165	103	103	32	302	0				
Jun-38	0.291	0.28	689	3092	11107	11543	3092	1807	1807	1403	1458	0	0	0	2496	0.264	4890	4611	2496	0	0	618	618	165	156	156	70	533	0				
Jul-38	0.515	0.28	1226	7072	11107	20429	7072	3227	3227	1403	2581	0	0	0	4453	0.471	4890	8226	4453	0	0	998	998	165	278	278	129	850	0				
Aug-38	0.409	0.50	787	1160	11107	9886	1160	2054	2054	1403	1148	0	0	0	2841	0.354	4890	3462	2841	0	0	815	815	165	117	117	98	796	0	12401	6936		
Sep-38	0.171	0.50	321	0	11107	3799	0	822	822	1403	480	0	0	0	1141					0	1141	374	374				42	417					
Oct-38		0.50	40	0				70	70					0	110					0	1250	79	79				7	86					
Nov-38			6	1				0	1					0	7					0	1257		0				0	0				

Petrolia Normal Storage (AF) = 14400 , Dead Storage = 0

(A) Date	(B) NIR Above Petrolia	(C) Eff Above Petrolia	(D) Yld Cr Entering Petrolia	(E) FW Cr Above Petrolia	(F) Pre 1950 Acres Abv Petrolia	(G) Pre 1950 Desired Diversion	(H) Pre 1950 Actual Diversion	(I) Return Flow	(J) Stream Flow	(K) Post 1950 Acres Abv Petrolia	(L) Post 1950 Desired Diversion	(M) Available Flow After Pet Rights	(N) Post 1950 Actual Diversion	(O) Return Flow	(P) Petrolia Reservoir Inflow	(Q) NIR Below Petrolia	(R) Pet 1950 Acres Below Res	(S) Pet 1950 Desired Diversion	(T) Pet 1950 Actual Diversion	(U) Spilled Flow	(V) Petrolia Res EOM Storage	(W) Pet. 1950 Return Flow	(X) Stream Flow	(Y) Pre 1950 Damscheo Acres	(Z) Damscheo Desired Diversion	(AA) Damscheo Actual Diversion	(AB) Damscheo Return Flow	(AC) Stream Flow	(AD) Pre 1950 Damscheo Shortage	(AE) Pet. 1950 Total Ann. Diversion	(AF) Pet. 1950 Total Ann Shortage	(AG) Weibull Plotting Position	(AH) Sorted Pet Ann Yields
Dec-38			0	139					139						139					0	1396		0					0				
Jan-39			0	123					123						123					0	1519		0					0				
Feb-39			0	164					164						164					0	1683		0					0				
Mar-39			0	814					814						814					0	2497		0					0				
Apr-39		0.28	0	91					91						91					0	2587		0					0				
May-39	0.195	0.28	314	4035	11107	7735	4035	1251	1251	1403	977	0	0	0	1565	0.174	4890	3039	3039	0	1114	434	434	165	103	103	32	364	0				
Jun-39	0.291	0.28	689	4214	11107	11543	4214	2182	2182	1403	1458	0	0	0	2871	0.264	4890	4611	3984	0	0	874	874	165	156	156	70	789	0				
Jul-39	0.515	0.28	1252	6247	11107	20429	6247	3226	3226	1403	2581	0	0	0	4478	0.471	4890	8226	4478	0	0	1169	1169	165	278	278	129	1021	0				
Aug-39	0.409	0.50	930	1125	11107	9086	1125	1972	1972	1403	1148	0	0	0	2903	0.354	4890	3462	2903	0	0	887	887	165	117	117	98	868	0	14404	4933		
Sep-39	0.171	0.50	416	0	11107	3799	0	738	738	1403	480	0	0	0	1154					0	1154	379	379				42	422					
Oct-39		0.50	77	0				67	68					0	145					0	1299	80	80				7	87					
Nov-39			6	1				0	1					0	7					0	1306		0				0	0				
Dec-39			0	74					74						74					0	1380		0					0				
Jan-40			0	66					66						66					0	1446		0					0				
Feb-40			0	215					215						215					0	1660		0					0				
Mar-40			0	382					382						382					0	2042		0					0				
Apr-40		0.28	0	3					3						3					0	2045		0					0				
May-40	0.195	0.28	314	3912	11107	7735	3912	1213	1213	1403	977	0	0	0	1527	0.174	4890	3039	3039	0	533	434	434	165	103	103	32	364	0				
Jun-40	0.291	0.28	689	2520	11107	11543	2520	1630	1630	1403	1458	0	0	0	2319	0.264	4890	4611	2852	0	0	712	712	165	156	156	70	627	0				
Jul-40	0.515	0.28	1085	5810	11107	20429	5810	2712	2712	1403	2581	0	0	0	3796	0.471	4890	8226	3796	0	0	958	958	165	278	278	129	810	0				
Aug-40	0.409	0.50	686	1123	11107	9886	1123	1720	1720	1403	1148	0	0	0	2405	0.354	4890	3462	2405	0	0	724	724	165	117	117	98	705	0	12092	7245		
Sep-40	0.171	0.50	276	0	11107	3799	0	698	698	1403	480	0	0	0	974					0	974	318	318				42	360					
Oct-40		0.50	39	0				67	68					0	107					0	1080	67	67				7	74					
Nov-40			6	1				0	1					0	7					0	1087		0				0	0				
Dec-40			0	0					0						0					0	1087		0					0				
Jan-41			0	0					0						0					0	1088		0					0				
Feb-41			0	4					4						4					0	1091		0					0				
Mar-41			0	0					0						0					0	1092		0					0				
Apr-41		0.28	0	0					0						0					0	1092		0					0				
Mar-41	0.195	0.28	314	3886	11107	7735	3886	1205	1205	1403	977	0	0	0	1519	0.174	4890	3039	2610	0	-0	373	373	165	103	103	32	382	0				
Jun-41	0.291	0.28	634	2652	11107	11543	2652	1665	1665	1403	1458	0	0	0	2299	0.264	4890	4611	2299	0	-0	590	590	165	156	156	70	585	0				
Jul-41	0.515	0.28	1058	6042	11107	20429	6042	2810	2810	1403	2581	0	0	0	3860	0.471	4890	8226	3860	0	-0	894	894	165	278	278	129	746	0				
Aug-41	0.409	0.50	705	1519	11107	9086	1519	1861	1861	1403	1148	0	0	0	2566	0.354	4890	3462	2566	0	-0	722	722	165	117	117	98	703	0	11336	8802		
Sep-41	0.171	0.50	388	0	11107	3799	0	775	775	1403	480	0	0	0	1075					0	1075	331	331				42	373					
Oct-41		0.50	49	1				91	92					0	141					0	1216	71	71				7	78					
Nov-41			6	10				0	10					0	17					0	1232		0				0	0				
Dec-41			0	825					825						825					0	2058		0					0				
Jan-42			0	651					651						651					0	2709		0					0				
Feb-42			0	571					571						571					0	3279		0					0				
Mar-42			0	674					674						674					0	3953		0					0				
Apr-42		0.28	0	3732					3732						3732					0	7685		0					0				
May-42	0.195	0.28	314	6665	11107	7735	6665	2066	2066	1403	977	0	0	0	2380	0.174	4890	3039	3039	0	7027	434	434	165	103	103	32	364	0				
Jun-42	0.291	0.28	2979	10489	11107	11543	10489	4698	4698	1403	1458	0	0	0	7677	0.264	4890	4611	4611	0	10894	963	963	165	156	156	70	878	0				
Jul-42	0.515	0.28	1252	6881	11107	20429	6881	5804	5804	1403	2581	0	0	0	6256	0.471	4890	8226	8226	0	8124	1768	1768	165	278	278	129	1619	0				
Aug-42	0.409	0.50	959	1739	11107	9086	1739	2799	2799	1403	1148	0	0	0	3759	0.354	4890	3462	3462	0	8421	1340	1340	165	117	117	98	1321	0	19337	0		
Sep-42	0.171	0.50	515	118	11107	3799	118	988	988	1403	480	0	0	0	1415					0	9835	576	576				42	618					
Oct-42		0.50	141	0				121	121					0	262					0	10098	96	96				7	103					
Nov-42			30	1				7	8					0	38					0	10135		0				0	0				
Dec-42			0	439					439						439					0	10574		0					0				
Jan-43			0	499					499						499					0	11074		0					0				
Feb-43			0	1153					1153						1153					0	12227		0					0				

Petrolia Normal Storage (AF) = 14400 , Dead Storage = 0

(A) Date	(B) NIR Above Petrolia	(C) Elf Above Petrolia	(D) YW Cr Entering Petrolia	(E) FW Cr Above Petrolia	(F) Pre 1950 Acres Abv Petrolia	(G) Pre 1950 Desired Diversion	(H) Pre 1950 Actual Diversion	(I) Return Flow	(J) Stream Flow	(K) Post 1950 Acres Abv Petrolia	(L) Post 1950 Desired Diversion	(M) Available Flow After Pet Rights	(N) Post 1950 Actual Diversion	(O) Return Flow	(P) Petrolia Reservoir Inflow	(Q) NIR Below Petrolia	(R) Pet 1950 Acres Below Res	(S) Pet 1950 Desired Diversion	(T) Pet 1950 Actual Diversion	(U) Spilled Flow	(V) Petrolia Res EOM Storage	(W) Pet. 1950 Return Flow	(Z) Stream Flow	(Y) Pre 1950 Danscheo Acres	(Z) Danschen Desired Diversioo	(AA) Danschen Actual Diversion	(AB) Danschen Return Flow	(AC) Stream Flow	(AD) Pre 1950 Danscheo Shortage	(AE) Pet. 1950 Total Aon. Diversion	(AF) Pet. 1950 Total Aon Shortage	(AG) Weibull Plotting Position	(AH) Sorted Pet Aon Yields
Mar-43			651	1978					1978						2630					457	14400		457					457				
Apr-43		0.28	227	574					574						811					811	14400		811					811				
May-43	0.195	0.28	807	4295	11107	7735	4295	1331	1331	1403	977	0	0	0	2136	0.174	4890	3039	3039	0	13499	434	434	165	103	103	32	364	0			
Jun-43	0.291	0.28	3260	10642	11107	11543	10642	4231	4231	1403	1458	1458	1458	452	6485	0.264	4890	4611	4611	973	14400	963	1937	165	156	156	70	1851	0			
Jul-43	0.515	0.28	1252	7472	11107	20429	7472	5825	5825	1403	2581	0	0	316	6593	0.471	4890	8226	8226	0	12768	1768	1768	165	278	278	129	1619	0			
Aug-43	0.409	0.50	959	1538	11107	9086	1538	2919	2919	1403	1148	0	0	136	4314	0.354	4890	3462	3462	0	13319	1340	1340	165	117	117	98	1321	0	19337	0	
Sep-43	0.171	0.50	515	0	11107	3799	0	918	918	1403	480	431	431	86	1681					0	14400	576	576				42	618				
Oct-43		0.50	141	0				92	93					68	294					294	14400	96	390				7	397				
Nov-43			30	1				0	1					25	56					56	14400		56				0	56				
Dec-43			0	365					365						365					365	14400		365					365				
Jan-44			0	286					286						286					286	14400		286					286				
Feb-44			0	333					333						333					333	14400		333					333				
Mar-44			0	788					788						788					788	14400		788					788				
Apr-44		0.28	0	71					71						71					71	14400		71					71				
May-44	0.195	0.28	512	3945	11107	7735	3945	1223	1223	1403	977	0	0	0	1735	0.174	4890	3039	3039	0	13097	434	434	165	103	103	32	364	0			
Jun-44	0.291	0.28	1084	5382	11107	11543	5382	2525	2525	1403	1458	0	0	0	3368	0.264	4890	4611	4611	0	12895	963	963	165	156	156	70	878	0			
Jul-44	0.515	0.28	1252	7051	11107	20429	7051	3721	3721	1403	2581	0	0	0	4973	0.471	4890	8226	8226	0	8842	1768	1768	165	278	278	129	1619	0			
Aug-44	0.409	0.50	959	1491	11107	9086	1491	2329	2329	1403	1148	0	0	0	3288	0.354	4890	3462	3462	0	8668	1340	1340	165	117	117	98	1321	0	19337	0	
Sep-44	0.171	0.50	515	0	11107	3799	0	864	864	1403	480	0	0	0	1379					0	10047	576	576				42	618				
Oct-44		0.50	141	0				89	90					0	231					0	10278	96	96				7	103				
Nov-44			30	1				0	1					0	30					0	10308		0				0	0				
Dec-44			0	296					296						296					0	10605		0					0				
Jan-45			0	269					269						269					0	10873		0					0				
Feb-45			0	224					224						224					0	11098		0					0				
Mar-45			0	373					373						373					0	11470		0					0				
Apr-45		0.28	0	2					2						2					0	11473		0					0				
May-45	0.195	0.28	314	3922	11107	7735	3922	1216	1216	1403	977	0	0	0	1530	0.174	4890	3039	3039	0	9964	434	434	165	103	103	32	364	0			
Jun-45	0.291	0.28	689	4070	11107	11543	4070	2113	2113	1403	1458	0	0	0	2802	0.264	4890	4611	4611	0	8155	963	963	165	156	156	70	878	0			
Jul-45	0.515	0.28	1252	6022	11107	20429	6022	3115	3115	1403	2581	0	0	0	4367	0.471	4890	8226	8226	0	4296	1768	1768	165	278	278	129	1619	0			
Aug-45	0.409	0.50	959	1125	11107	9086	1125	1910	1910	1403	1148	0	0	0	2870	0.354	4890	3462	3462	0	3704	1340	1340	165	117	117	98	1321	0	19337	0	
Sep-45	0.171	0.50	515	0	11107	3799	0	718	718	1403	480	0	0	0	1233					0	4937	576	576				42	618				
Oct-45		0.50	141	0				68	68					0	209					0	5146	96	96				7	103				
Nov-45			30	1				0	1					0	30					0	5176		0				0	0				
Dec-45			0	134					134						134					0	5310		0					0				
Jan-46			0	305					305						305					0	5616		0					0				
Feb-46			0	302					302						302					0	5917		0					0				
Mar-46			0	405					405						405					0	6323		0					0				
Apr-46		0.28	0	4					4						4					0	6327		0					0				
May-46	0.195	0.28	314	3947	11107	7735	3947	1224	1224	1403	977	0	0	0	1538	0.174	4890	3039	3039	0	4826	434	434	165	103	103	32	364	0			
Jun-46	0.291	0.28	689	3167	11107	11543	3167	1838	1838	1403	1458	0	0	0	2527	0.264	4890	4611	4611	0	2742	963	963	165	156	156	70	878	0			
Jul-46	0.515	0.28	1252	5914	11107	20429	5914	2888	2888	1403	2581	0	0	0	4139	0.471	4890	8226	6881	0	0	1575	1575	165	278	278	129	1427	0			
Aug-46	0.409	0.50	959	1123	11107	9086	1123	1802	1862	1403	1148	0	0	0	2762	0.354	4890	3462	2762	0	0	1141	1141	165	117	117	98	1122	0	17292	2045	
Sep-46	0.171	0.50	515	0	11107	3799	0	707	707	1403	480	0	0	0	1222					0	1222	473	473				42	516				
Oct-46		0.50	141	0				67	68					0	209					0	1431	76	76				7	83				
Nov-46			30	1				0	1					0	30					0	1462		0				0	0				
Dec-46			0	178					178						178					0	1640		0					0				
Jan-47			0	151					151						151					0	1790		0					0				
Feb-47			0	270					270						270					0	2060		0					0				
Mar-47			0	1761					1761						1761					0	3821		0					0				
Apr-47		0.28	0	3835					3835						3835					0	7656		0					0				
May-47	0.195	0.28	314	4129	11107	7735	4129	1280	1280	1403	977	0	0	0	1594	0.174	4890	3039	3039	0	6211	434	434	165	103	103	32	364	0			

Petrolia Normal Storage (AF) = 14400 , Dead Storage = 0

(A) Date	(B) NIR Above Petrolia	(C) Eff Ww Cr Above Petrolia	(D) Ww Cr Entering Petrolia	(E) Fw Cr Above Petrolia	(F) Pre 1950 Acres Abv Petrolia	(G) Pre 1950 Desired Diversion	(H) Pre 1950 Actual Diversion	(I) Return Flow	(J) Stream Flow	(K) Post 1950 Acres Abv Petrolia	(L) Post 1950 Desired Diversion	(M) Available Flow After Pet Rights	(N) Post 1950 Actual Diversion	(O) Return Flow	(P) Petrolia Reservoir Inflow	(Q) NIR Below Petrolia	(R) Pet 1950 Acres Below Res	(S) Pet 1950 Desired Diversion	(T) Pet 1950 Actual Diversion	(U) Spilled Flow	(V) Petrolia Res EOM Storage	(W) Pet. 1950 Return Flow	(X) Stream Flow	(Y) Pre 1950 Damschen Acres	(Z) Damschen Desired Diversion	(AA) Damschen Actual Diversion	(AB) Damschen Return Flow	(AC) Stream Flow	(AD) Pre 1950 Damschen Shortage	(AE) Pet. 1950 Total Ann. Diversion	(AF) Total Ann Shortage	(AG) Weibull Plotting Position	(AH) Sorted Pet Ann Yields
Jun-47	0.291	0.28	689	3841	11107	11543	3841	2087	2087	1403	1458	0	0	0	2776	0.264	4890	4611	4611	0	4376	963	963	165	156	156	70	878	0				
Jul-47	0.515	0.28	1252	5958	11107	20429	5958	3062	3062	1403	2581	0	0	0	4314	0.471	4890	8226	8226	0	464	1768	1768	165	278	278	129	1619	0				
Aug-47	0.409	0.50	959	1131	11107	9086	1131	1875	1875	1403	1148	0	0	0	2834	0.354	4890	3462	3298	0	0	1325	1325	165	117	117	98	1386	0	19173	164		
Sep-47	0.171	0.50	515	0	11107	3799	0	712	712	1403	480	0	0	0	1227					0	1227	566	566				42	608					
Oct-47		0.50	141	0				68	68					0	209					0	1436	91	91				7	98					
Nov-47			30	1				0	1					0	30					0	1467		0				0	0					
Dec-47			0	143					143						143					0	1610		0					0				
Jan-48			0	221					221						221					0	1831		0					0				
Feb-48			0	240					240						240					0	2071		0					0				
Mar-48			0	479					479						479					0	2550		0					0				
Apr-48		0.28	0	58					58						58					0	2608		0					0				
May-48	0.195	0.28	314	4738	11107	7735	4738	1469	1469	1403	977	0	0	0	1783	0.174	4890	3039	3039	0	1352	434	434	165	103	103	32	364	0				
Jun-48	0.291	0.28	2531	10398	11107	11543	10398	4249	4249	1403	1458	0	0	0	6780	0.264	4890	4611	4611	0	3521	963	963	165	156	156	70	878	0				
Jul-48	0.515	0.28	3103	12388	11107	20429	12388	6511	6511	1403	2581	0	0	0	9613	0.471	4890	8226	8226	0	4909	1768	1768	165	278	278	129	1619	0				
Aug-48	0.409	0.50	959	1683	11107	9086	1683	3974	3974	1403	1148	0	0	0	4933	0.354	4890	3462	3462	0	6386	1340	1340	165	117	117	98	1321	0	19337	0		
Sep-48	0.171	0.50	515	0	11107	3799	0	1360	1360	1403	480	0	0	0	1895					0	8275	576	576				42	618					
Oct-48		0.50	141	0				101	101					0	242					0	8518	96	96				7	103					
Nov-48			30	99				0	99					0	129					0	8647		0				0	0				
Dec-48			0	185					185						185					0	8832		0					0				
Jan-49			0	140					140						140					0	8971		0					0				
Feb-49			0	580					580						580					0	9551		0					0				
Mar-49			1628	3394					3394						4421					0	13972		0					0				
Apr-49		0.28	100	386					386						545					118	14488		118					118				
May-49	0.195	0.28	796	4270	11107	7735	4270	1324	1324	1403	977	0	0	0	2120	0.174	4890	3039	3039	0	13481	434	434	165	103	103	32	364	0				
Jun-49	0.291	0.28	986	4953	11107	11543	4953	2462	2462	1403	1458	0	0	0	3368	0.264	4890	4611	4611	0	12239	963	963	165	156	156	70	878	0				
Jul-49	0.515	0.28	1468	8326	11107	20429	8326	4053	4053	1403	2581	0	0	0	5521	0.471	4890	8226	8226	0	9535	1768	1768	165	278	278	129	1619	0				
Aug-49	0.409	0.50	959	1353	11107	9086	1353	2538	2538	1403	1148	0	0	0	3497	0.354	4890	3462	3462	0	9570	1340	1340	165	117	117	98	1321	0	19337	0		
Sep-49	0.171	0.50	515	0	11107	3799	0	964	964	1403	480	0	0	0	1479					0	11049	576	576				42	618					
Oct-49		0.50	141	0				81	82					0	223					0	11271	96	96				7	103					
Nov-49			30	0				0	0					0	30					0	11302		0				0	0				
Dec-49			0	0					0						0					0	11302		0					0				
Jan-50			0	0					0						0					0	11302		0					0				
Feb-50			0	23					23						23					0	11325		0					0				
Mar-50			0	847					847						847					0	12172		0					0				
Apr-50		0.28	0	562					562						562					0	12734		0					0				
May-50	0.195	0.28	454	4252	11107	7735	4252	1318	1318	1403	977	0	0	0	1772	0.174	4890	3039	3039	0	11466	434	434	165	103	103	32	364	0				
Jun-50	0.291	0.28	1024	5237	11107	11543	5237	2546	2546	1403	1458	0	0	0	3570	0.264	4890	4611	4611	0	10426	963	963	165	156	156	70	878	0				
Jul-50	0.515	0.28	1626	8706	11107	20429	8706	4231	4231	1403	2581	0	0	0	5856	0.471	4890	8226	8226	0	8056	1768	1768	165	278	278	129	1619	0				
Aug-50	0.409	0.50	959	1378	11107	9086	1378	2652	2652	1403	1148	0	0	0	3611	0.354	4890	3462	3462	0	8205	1340	1340	165	117	117	98	1321	0	19337	0		
Sep-50	0.171	0.50	515	0	11107	3799	0	1003	1003	1403	480	0	0	0	1518					0	9723	576	576				42	618					
Oct-50		0.50	141	0				83	83					0	224					0	9947	96	96				7	103					
Nov-50			30	0				0	0					0	30					0	9977		0				0	0				
Dec-50			0	103					103						103					0	10081		0					0				
			0	126																													
			0	212																													
			0	1331																													
			283	1129																													

Total Damschen Shortage (af)= 0
Firm Petrolia Yield (af) = 10810
80% Petrolia Yield (af) = 12401

APPENDIX B
FLATWILLOW CREEK BASIN MODEL
COLUMN DESCRIPTIONS

A. Date.

B. Net irrigation requirement above Petrolia in feet: from SCS Irrigation Guide.

C. Irrigation efficiency.

D. Yellow Water Creek entering Petrolia in AF: from Yellow Water model.

E. Flatwillow Creek inflow to Petrolia model in AF: from Yellow Water model.

F. Pre-1950 acres above Petrolia.

G. Pre-1950 desired diversion in AF: equal to Col. F x Col. B / Col. C.

H. Pre-1950 actual diversion in AF: equal to the lesser of Col. E and Col. G.

I. Pre-1950 return flow in AF: For each month's diversion, the amount that returns to the creek is equal to the diversion minus consumptive use and irrecoverable loss, or Col. H x (0.9 - Col. E). This volume is distributed among the next few months according to the pattern: 50% in the first month, 35% in the second month, 15% in the third month. For example, the August return flow is equal to 0.5 x Col. H August x (0.9 - Col. E August) + 0.35 x Col. H July x (0.9 - Col. E July) + 0.15 x Col. H June x (0.9 - Col E June).

J. Streamflow in AF: equal to Col. E - Col. H + Col. I.

K. Post-1950 acres above Petrolia.

L. Post-1950 desired diversion in AF: equal to Col. K x Col. B / Col. C.

M. Available flow for Post-1950 diversion in AF after 1950 Petrolia rights have been satisfied. If the unappropriated flow; Col. J + Col. D + Col. V for the previous month - Col. S - normal storage + return flows from Post-1950

diversions in the previous two months is less than or equal to zero, the available flow for Post-1950 diversion is zero. If not, the maximum Post-1950 depletion is set equal to the unappropriated flow, where depletion is the diversion minus return flow for the present month. Since return flow for the present month is equal to diversion x 0.5 x (0.9 - Col. C) maximum available flow can be solved for directly by dividing unappropriated flow by the quantity [1 - .5 x (0.9 - Col. C)]. The lesser of the computed quantity and the desired diversion (Col. L) is the solution.

N. Post-1950 actual diversion in AF: equal to the lesser of Col. J and Col. M.

O. Post-1950 return flow in AF: Same as Col. I with Col. N substituted for Col. H.

P. Petrolia Reservoir inflow in AF: equal to Col. J - Col. N + Col. O + Col. D.

Q. Net irrigation requirement below Petrolia in feet: from SCS Irrigation Guide.

R. Petrolia 1950 acres below reservoir.

S. Petrolia 1950 desired diversion in AF: equal to Col. R x Col. Q / Col. C.

T. Petrolia 1950 actual diversion in AF: equal to the lesser of Col. S and (Col. V previous month + Col. P - dead storage). Dead storage is equal to 162 acre feet.

U. Spilled flow from Petrolia Reservoir in AF: equal to the amount of flow in excess of normal storage (Col. V. previous month + Col. P - Col. T - normal storage) if any.

V. Petrolia Reservoir end of month storage in AF: equal to Col. V previous month + Col. P - Col. T - Col. V.

W. Petrolia 1950 return flow in AF: same as Col. I with Col. T substituted for Col. HY, and multiplied by (2255 / Col. S). In this equation 2255 is the number of acres in the Petrolia project that supplies return flows to the stream

that are available for use by direct flow rights downstream. The remaining 2635 acres do not return for re-use in this model.

X. Streamflow in AF: equal to Col. U + Col. W.

Y. Pre-1950 direct flow acres.

Z. Pre-1950 desired diversion in AF: equal to Col. Y x Col. Q / Col. C.

AA. Pre-1950 actual diversion in AF: equal to the lesser of Col. Z and Col. X.

AB. Pre-1950 return flow in AF: same as Col. I with Col. AA substituted for Col. H.

AC. Streamflow in AF: equal to Col. X - Col. AA + Col. AB.

AD. Pre-1950 direct flow shortage in AF: equal to Col. Z - Col. AA. This column is a check on the validity of the assumption that all of the pre-1950 diversions below Petrolia Reservoir could be served by the return flow from the Petrolia project.

AE. Petrolia 1950 total annual diversion or yield in AF: equal to the sum of the diversions to the Petrolia project for each year (Col. T).

AF. Petrolia 1950 total annual shortage in AF: equal to the sum of the desired diversions in Col. S for a given year minus the result in Col. AG.

AG. Weibull plotting position: equal to the series n / (total number of years + 1), where n goes from 1 to the total number of years (29). This plotting position represents the chance of exceedance.

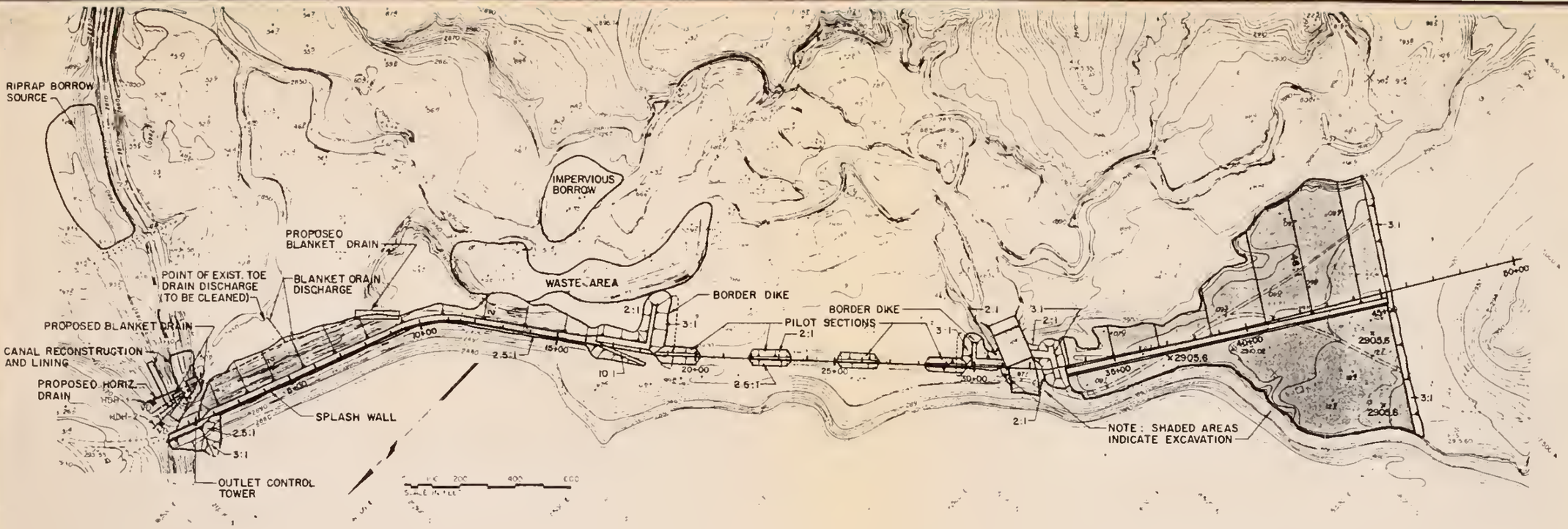
AH. Petrolia annual yields from Col. AE rearranged in descending order. Columns AG and AH present the results of the analysis of yield to Petrolia Project lands. The lowest value (96.7% chance) is approximately equal to the "firm yield" of the system. The 80% chance yield is the water supply in 8 out of 10 years.

0

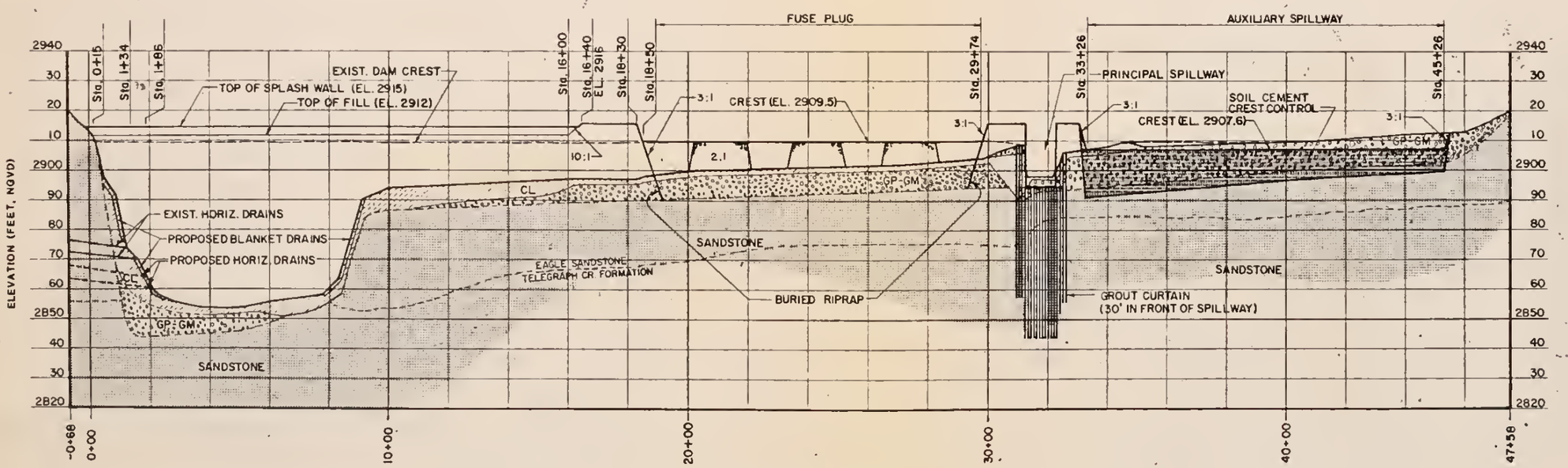
B15: (F3) 0.409
C15: (F2) [W10] 0.5
D15: 959.39582143
E15: [W10] 1214.4384612
F15: 11107
G15: [W11] +F15*B15/C15
H15: @IF(E15>G15,B15,E15)
I15: 0.5*H15*(0.9-$C15)+0.35*H14*(0.9-$C14)+0.15*H13*(0.9-$C13)
J15: +E15-H15-I15
K15: [W10] 1403
L15: [W10] +K15*B15/C15
M15: [W11] @IF(J15+D15+V14-S15-E1+0.35*N14*(0.9-C14)+0.15*N13*(0.9-C13)>0,@IF((J15+D15+V14-S15-E1+0.35*N14*(0.9-C14)+0.15*N13*(0.9-C13))/(0.55+0.5*C15)>L15,L15,(J15+D15+V14-S15-E1+0.35*N14*(0.9-C14)+0.15*N13*(0.9-C13))/(0.55+0.5*C15)),0)
N15: [W11] @IF(M15>L15,L15,M15)
O15: 0.5*N15*(0.9-$C15)+0.35*N14*(0.9-$C14)+0.15*N13*(0.9-$C13)
P15: +J15-N15+O15+D15
Q15: (F3) [W10] 0.354
R15: [W10] 4090
S15: [W10] +R15*D15/C15
T15: [W10] @IF(V14+P15-H1<S15,S15,V14+P15-H1)
U15: @IF(V14+P15-T15>E1,V14+P15-T15-E1,0)
V15: +V14+P15-T15-U15
W15: (0.5*T15*(0.9-$C15)+0.35*T14*(0.9-$C14)+0.15*T13*(0.9-$C13))*2255/R$12
X15: [W10] +U15+W15
Y15: [W10] 165
Z15: [W10] +Y15*C15/C15
AA15: @IF(X15>Z15,Z15,X15)
AB15: [W10] 0.5*AA15*(0.9-$C15)+0.35*AA14*(0.9-$C14)+0.15*AA13*(0.9-$C13)
AC15: [W10] +X15-AA15+AB15
AD15: +Z15-AA15
AE15: [W10] @SUM($T12..$T15)
AF15: @SUM(S12..S15)-AE15
AG15: (F3) [W10] +AG14+1/30
AH15: [W10] +AE15
0

APPENDIX C

PLAN SHEETS



PLAN



NOTE:
GEOLOGIC PROFILE ALONG TOE OF EMBANKMENT PROJECTED TO CENTER-LINE OF EXISTING DAM

NEW DAM CREST CENTERLINE PROFILE

No	Revision	By	Date
1	[illegible]	TLD	6/26/89
2	[illegible]	DMW	8/28/89

Drawn ___ Checked ___ Approved ___

Designed ___ Date June 13, 1988

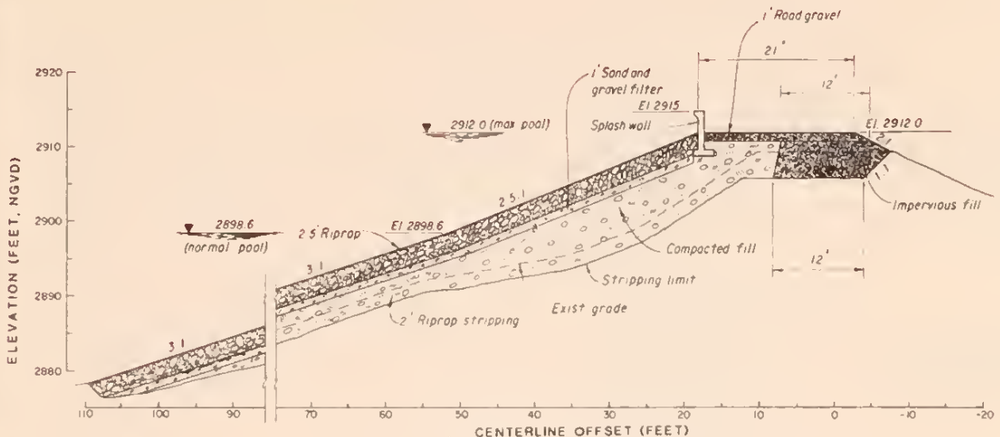
Project No. 3M087.118 I.D. No. ___

PETROLIA DAM REHABILITATION

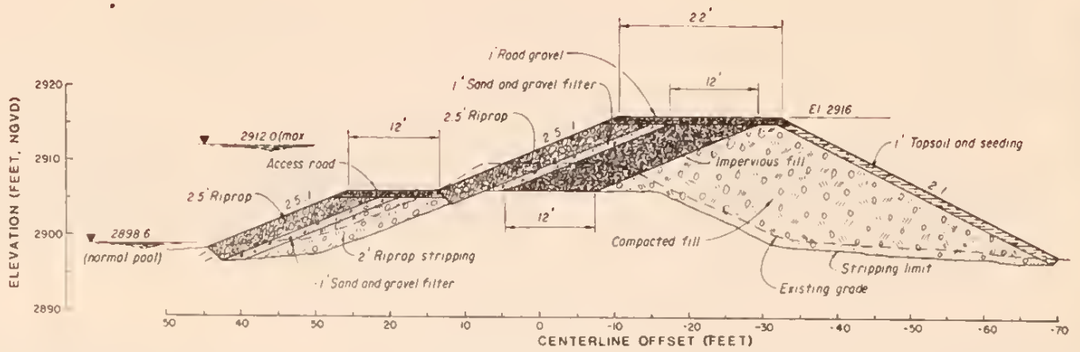
RECOMMENDED GENERAL SITE PLAN AND PROFILE

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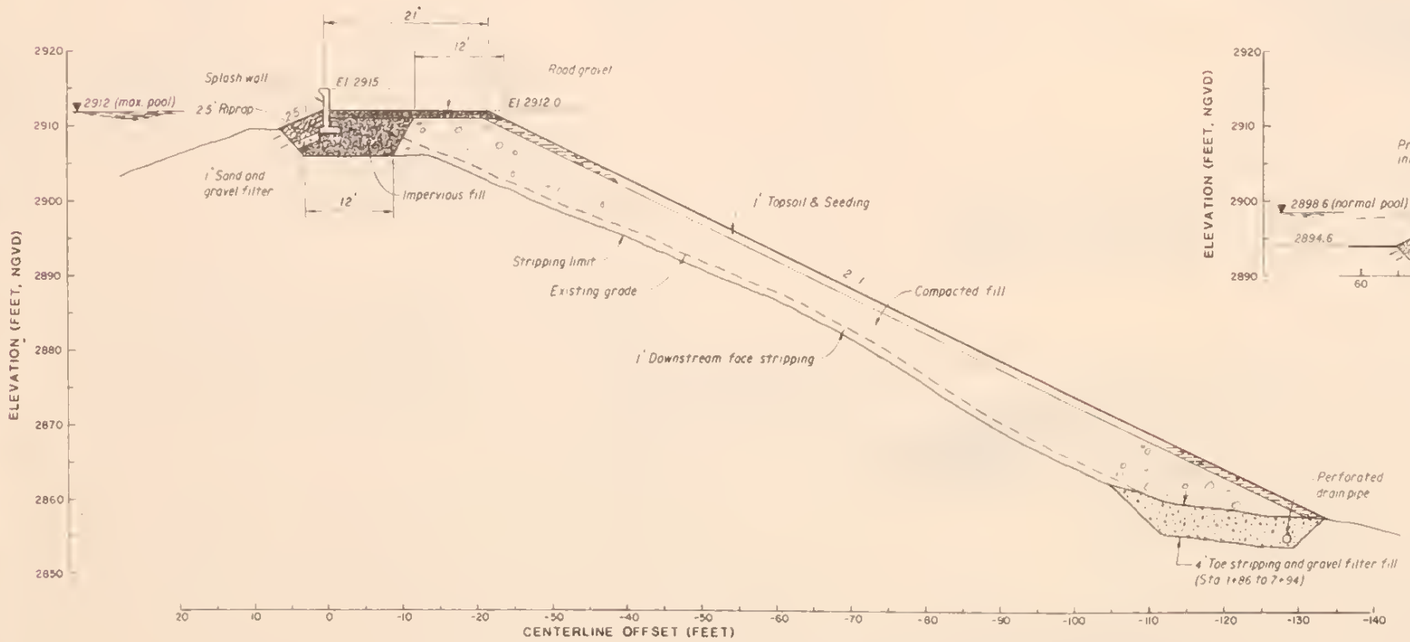
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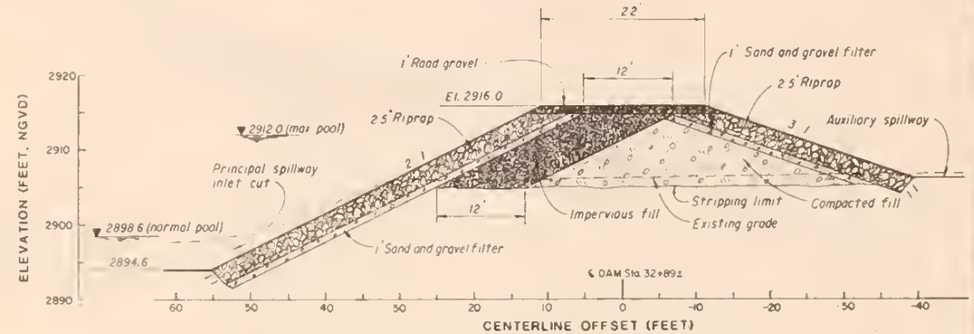
TYPICAL EMBANKMENT SECTION - Sta. 0+15 to 1+34



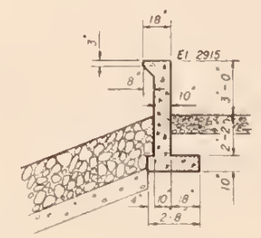
TYPICAL EMBANKMENT SECTION - Sta. 16+40 to 17+80



TYPICAL EMBANKMENT SECTION - Sta 1+86 to 16+00



TYPICAL EMBANKMENT SECTION
AT 0AM ℄ Sta. 32+89±



TYPICAL SPLASH WALL - Sta 0+15 to 16+40

NOT TO SCALE

No	Revision	By	Date
1	Drafting standards revisions, corrected ℄ offsets, added notes	SLB	6/20/86
2	Changed riprap to 2.5 thick, added riprap stripping typical sect.	SLC	8/19/86

Drawn — Checked — Approved

Designed — Date JUNE 18, 1986

I.D. No

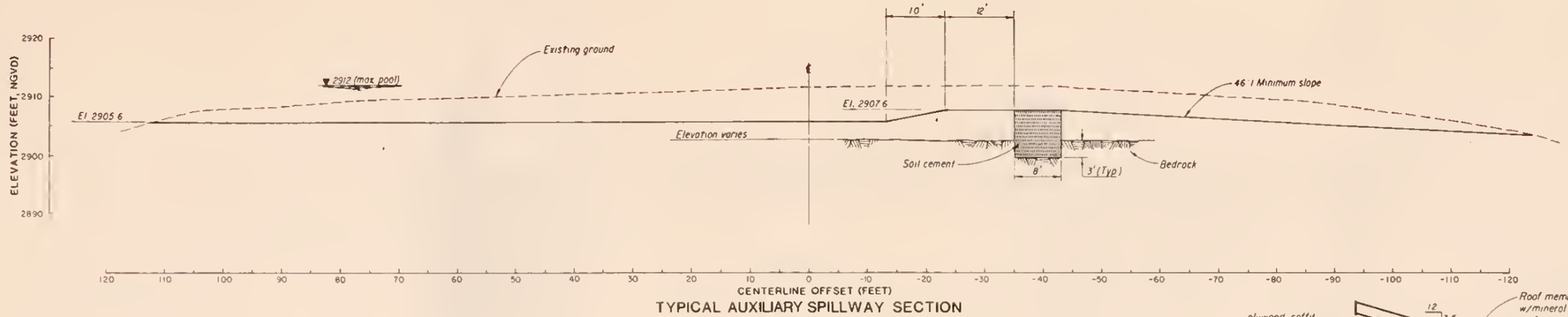
Project No

PETROLIA DAM REHABILITATION

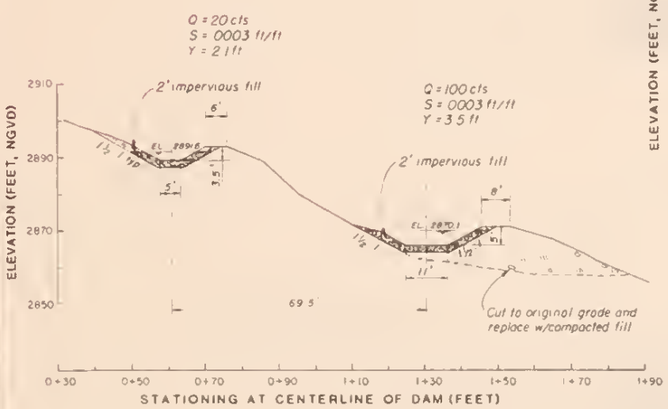
RECOMMENDED EMBANKMENT
CROSS SECTIONS

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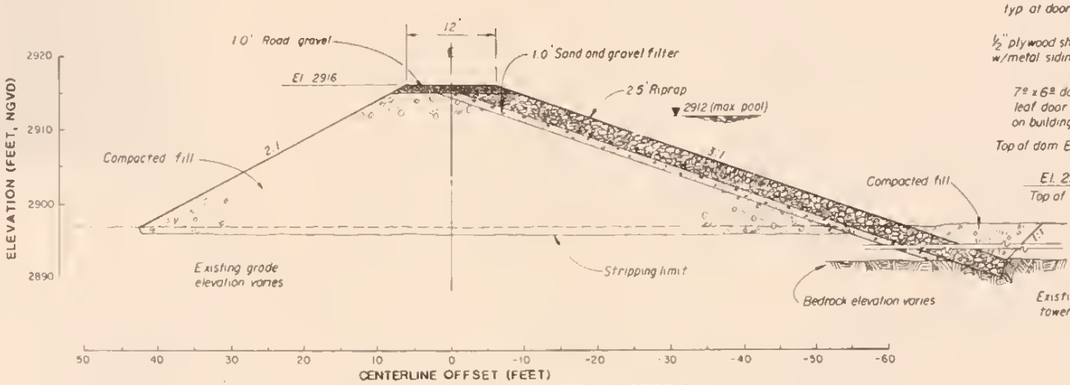
Sheet No.
C.2
of



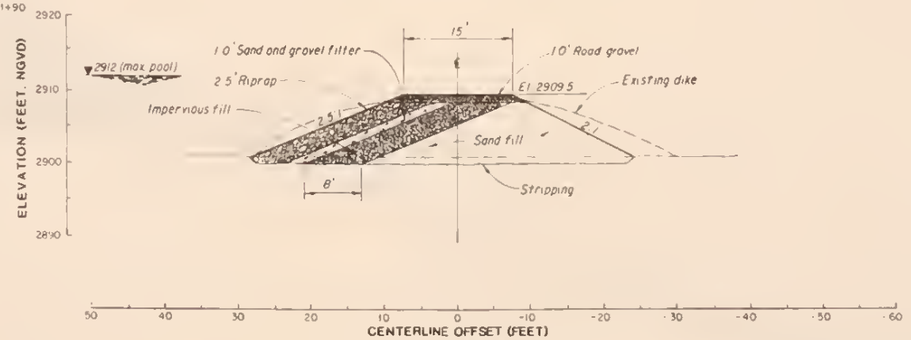
TYPICAL AUXILIARY SPILLWAY SECTION



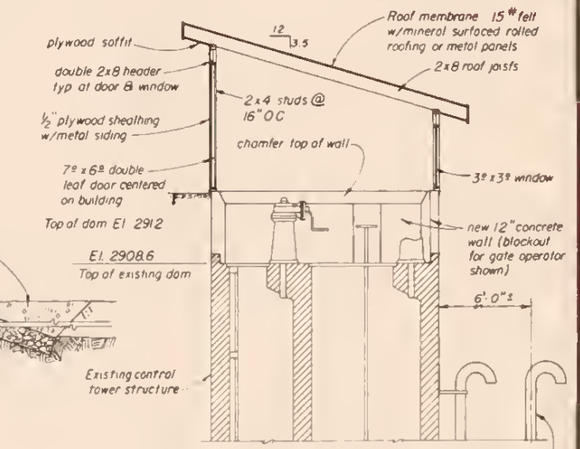
TYPICAL SECTION THROUGH CANALS



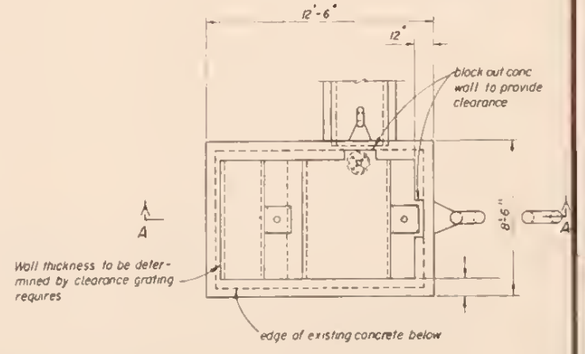
TYPICAL AUXILARY SPILLWAY BORDER DIKE SECTION
℄ BORDER DIKE AT DAM ℄ Sta. 18+24
℄ BORDER DIKE AT DAM ℄ Sta. 29+99



TYPICAL FUSE PLUG PILOT SECTION
Sta. 19+50 to Sta. 20+20
Sta. 21+91 to Sta. 23+45
Sta. 25+08 to Sta. 26+58
Sta. 28+21 to Sta. 29+74



SECTION A-A



PLAN

CONTROL TOWER MODIFICATIONS

SCALE OF FEET 0 5 10

PETROLIA DAM REHABILITATION

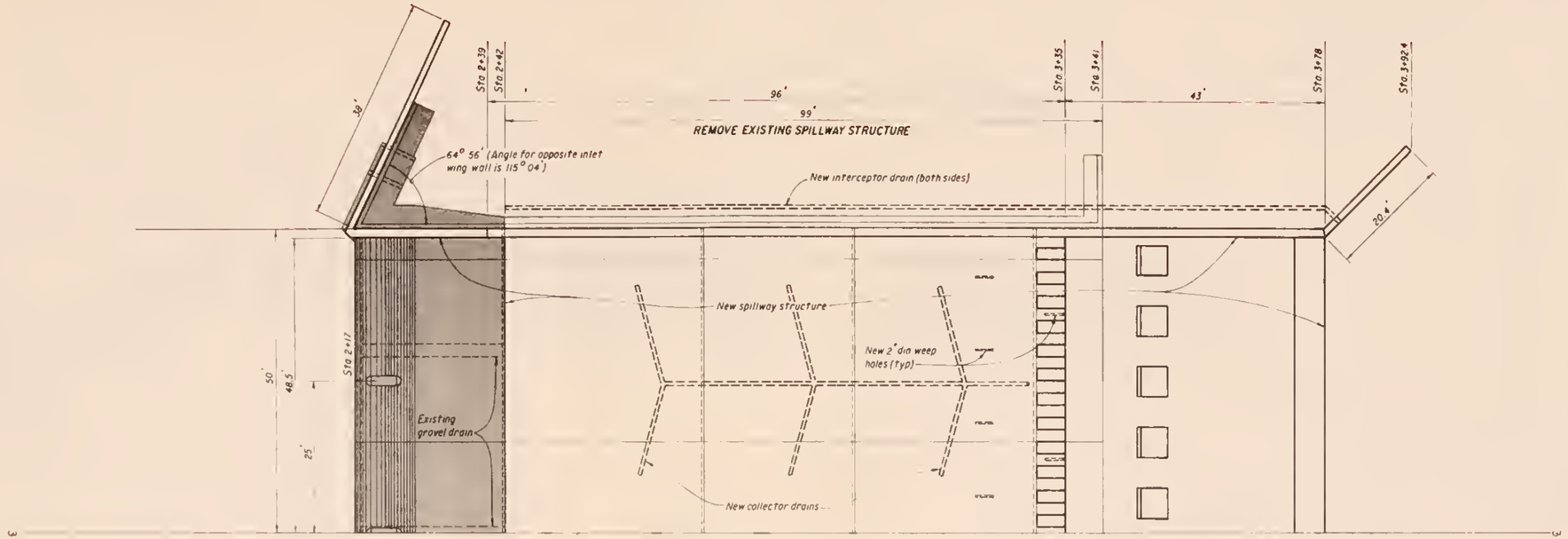
RECOMMENDED AUXILIARY SPILLWAY CROSS SECTIONS & CONTROL TOWER MODIFICATIONS

No.	Revision	By	Date
1	Added detail of modifications to existing control tower	SLB	6/27/86
2	Revised control tower detail & added typical control section	DMM	9/17/86

Drawn ___ Checked ___ Approved ___
Date JUNE 13, 1986 Designed ___
I.D. No ___
Project No ___

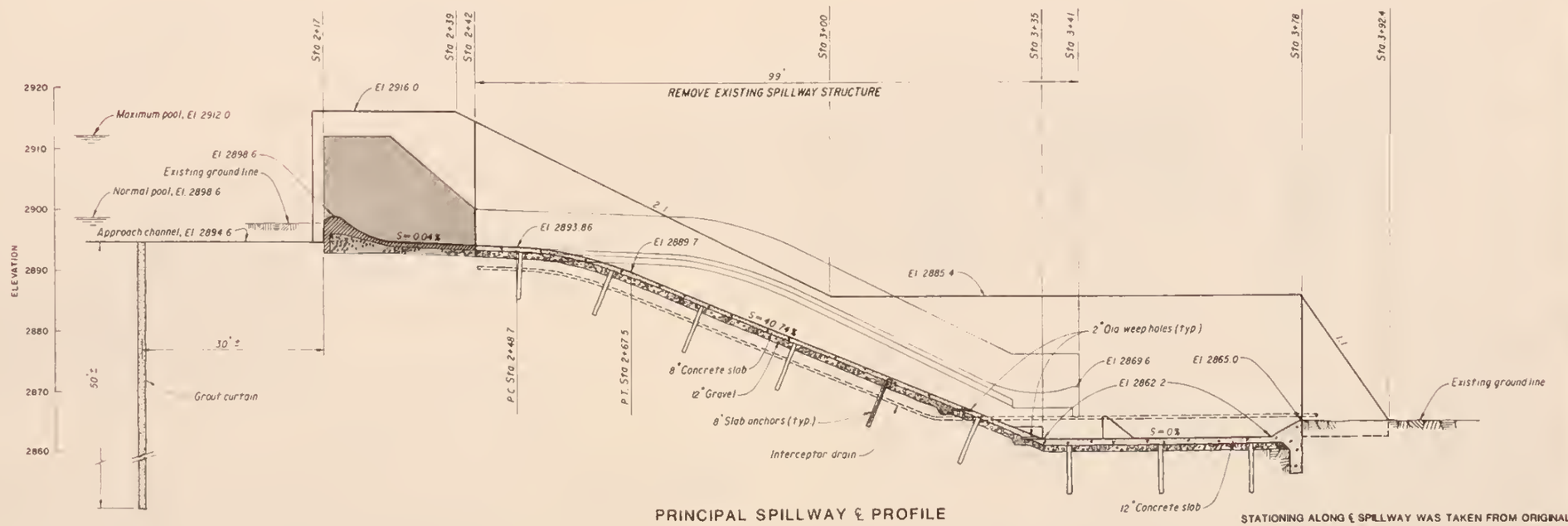
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Sheet No C.3 of ___



PRINCIPAL SPILLWAY HALF PLAN

SCALE OF FEET



PRINCIPAL SPILLWAY & PROFILE

STATIONING ALONG ℄ SPILLWAY WAS TAKEN FROM ORIGINAL PLAN

No	Revision	By	Date
1	Drafting standards revised and minor modifications to plan and profile	SLH	6/26/90
2	Add collector drains, 2 weep holes at spillway, & minor grading to control drainage to holes above grout curtain.	SLH	9/27/90

Project No ____ ID No ____ Date JUNE 13, 1988 Designed ____ Drawn ____ Checked ____ Approved ____

PETROLIA DAM REHABILITATION

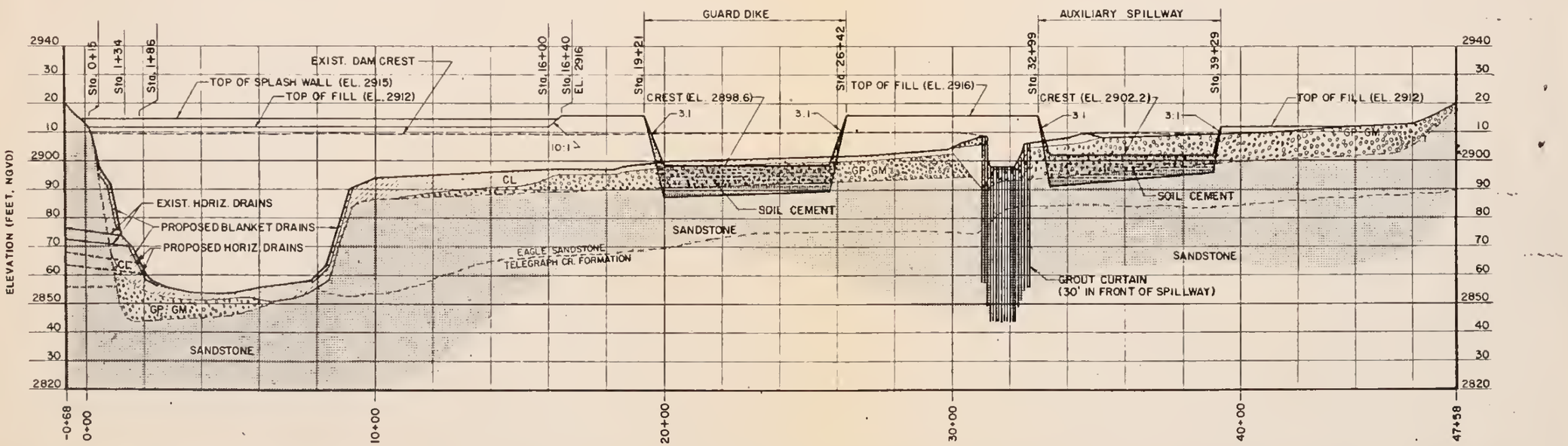
EXISTING SPILLWAY REHABILITATION

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Sheet No. C.4 of ____

RIPRAP BORROW SOURCE
IMPERVIOUS BORROW
PROPOSED BLANKET DRAIN
PRINCIPAL SPILLWAY
FUSE PLUG
POINT OF EXIST. TOE DRAIN DISCHARGE (TO BE CLEANED)
BLANKET DRAIN DISCHARGE
WASTE AREA
PROPOSED BLANKET DRAIN
CANAL RECONSTRUCTION AND LINING
PROPOSED HORIZ. DRAIN
SPLASH WALL
OUTLET CONTROL TOWER
GUARD DIKE
NOTE: SHADED AREAS INDICATE EXCAVATION
SCALE IN FEET

PLAN



NOTE:
GEOLOGIC PROFILE ALONG TOE OF EMBANKMENT PROJECTED TO CENTER-LINE OF EXISTING DAM

NEW DAM CREST CENTERLINE PROFILE

Project No. 3M0917.119 ID No ____ Date JUNE 13, 1985 Designed ____ Drawn ____ Checked ____ Approved ____

No	Revision	By	Date
1	[illegible]	SLK	6/24/85
2	[illegible]	DMH	8/26/85

PETROLIA DAM REHABILITATION

ALTERNATIVE GENERAL SITE PLAN & PROFILE

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Sheridan, Wyoming

Sheet No C.5 of ____

APPENDIX D

ADDITIONAL GEOTECHNICAL DATA

HKM ASSOCIATES
BILLINGS, MONTANA

LOG OF EXPLORATION HOLES

PROJECT Petrolia Dam
JOB NO. 3M087.118
LOCATION Upstream of dike

HOLE NO. TP-301
SHEET 1 OF 1
SURFACE ELEV. 2902.4

DRILL TYPE Backhoe
DRILLER —
FIELD ENG./GEOLOGIST DLD

GROUNDWATER none
TOTAL DEPTH 9.3'
HOLE STARTED 1-20-86 FINISHED 1-20-86

DEPTH FEET	LEGEND	DESCRIPTION OF MATERIAL	SAMPLE TYPE	SAMPLE FROM	SAMPLE TO	BLOWS N	M.C. %	γd pcf	L.L. %	P.I. %	NOTES
		TOPSOIL; with organics									Frost Depth at 4.0'
1.0		LEAN CLAY with SAND; moist, stiff.									
5.8		POORLY GRADED GRAVEL with SILT and SAND; moist, compact, subrounded									
8.2		SANDSTONE; highly, weathered, clayey									
9.3											

HKM ASSOCIATES
BILLINGS, MONTANA

LOG OF EXPLORATION HOLES

PROJECT: Petrolia Dam
JOB NO.: 3M087.118
LOCATION: Downstream of dike

HOLE NO.: TP-302
SHEET: 1 OF 1
SURFACE ELEV.: 2894.2

DRILL TYPE: Backhoe
DRILLER:
FIELD ENG./GEOLOGIST: DLD

GROUNDWATER: none
TOTAL DEPTH: 8.0'
HOLE STARTED: 1-20-86 FINISHED: 1-20-86

DEPTH FEET	LEGEND	DESCRIPTION OF MATERIAL	SAMPLE TYPE	SAMPLE FROM	SAMPLE TO	BLOWS N	M.C. %	γd pcf	L.L. %	P.I. %	NOTES
		TOPSOIL; with organics, sandy clay.									
1.0		LEAN CLAY with SAND; moist, stiff.									
1.8		POORLY GRADED GRAVEL with SAND (GP); moist, compact, 6" maximum size observed, subrounded and elongated gravel	Sack	2	7						See Plate No. 1 for additional information.
7.0		SANDSTONE; highly weathered, poorly cemented.									
8.0											

HKM ASSOCIATES
BILLINGS, MONTANA

LOG OF EXPLORATION HOLES

PROJECT Petrolia Dam
JOB NO. 3M087.118
LOCATION Downstream of Dike

HOLE NO. TP-303
SHEET 1 OF 1
SURFACE ELEV. 2898.3

DRILL TYPE Backhoe
DRILLER —
FIELD ENG./GEOLOGIST DLD

GROUNDWATER none
TOTAL DEPTH 8.9'
HOLE STARTED 1-20-86 FINISHED 1-20-86

DEPTH FEET	LEGEND	DESCRIPTION OF MATERIAL	SAMPLE TYPE	SAMPLE FROM	SAMPLE TO	BLOWS N	M.C. %	γd pcf	L.L. %	P.I. %	NOTES
		TOPSOIL; with organics									
1.0											
		LEAN CLAY with SAND; moist, stiff									
1.6		POORLY GRADED GRAVEL with SILTY CLAY and SAND(GP-GC); moist, compact to dense	Sack	2	6				27	14	See Plate No. 2 for additional information.
7.2		SANDSTONE; highly weathered greenish gray.									
8.9											

HKM ASSOCIATES
BILLINGS, MONTANA

LOG OF EXPLORATION HOLES

PROJECT Petrolia Dam
JOB NO. 8M087.118
LOCATION Old borrow area

HOLE NO. TP-304
SHEET 1 OF 1
SURFACE ELEV. 2878.8

DRILL TYPE Backhoe
DRILLER —
FIELD ENG./GEOLOGIST DLD

GROUNDWATER none
TOTAL DEPTH 4.0'
HOLE STARTED 1-20-86 FINISHED 1-20-86

DEPTH FEET	LEGEND	DESCRIPTION OF MATERIAL	SAMPLE TYPE	SAMPLE FROM	SAMPLE TO	BLOWS N	M.C. %	γd pcf	L.L. %	P.I. %	NOTES
		TOPSOIL; with organics									
1.0		LEAN CLAY with SAND; moist, stiff									
2.0		POORLY GRADED GRAVEL with SILT and SAND; moist, loose									
3.0		SANDY SHALE; weathered, gray	Sack	3	4						
4.0											

HKM ASSOCIATES
BILLINGS, MONTANA

LOG OF EXPLORATION HOLES

PROJECT Petrolia Dam
JOB NO. 3M087.118
LOCATION Johnson Coulee

HOLE NO. TP-305
SHEET 1 OF 1
SURFACE ELEV. 2866.6

DRILL TYPE Backhoe
DRILLER –
FIELD ENG. / GEOLOGIST DLD

GROUNDWATER none
TOTAL DEPTH 1.8'
HOLE STARTED 1-20-86 FINISHED 1-20-86

DEPTH FEET	LEGEND	DESCRIPTION OF MATERIAL	SAMPLE TYPE	SAMPLE FROM	SAMPLE TO	BLOWS N	M.C. %	γd pcf	L.L. %	P.I. %	NOTES
0.5		TOPSOIL; with organics									
1.8		SANDSTONE; weathered and fractured to 1.5'									

HKM ASSOCIATES
BILLINGS, MONTANA

LOG OF EXPLORATION HOLES

PROJECT Petrolia Dam
JOB NO. 3M087.118
LOCATION Johnson Coulee

HOLE NO. TP-306
SHEET 1 OF 1
SURFACE ELEV. 2863.3

DRILL TYPE Backhoe
DRILLER —
FIELD ENG./GEOLOGIST DLD

GROUNDWATER none
TOTAL DEPTH 7.6
HOLE STARTED 1-20-86 FINISHED 1-20-86

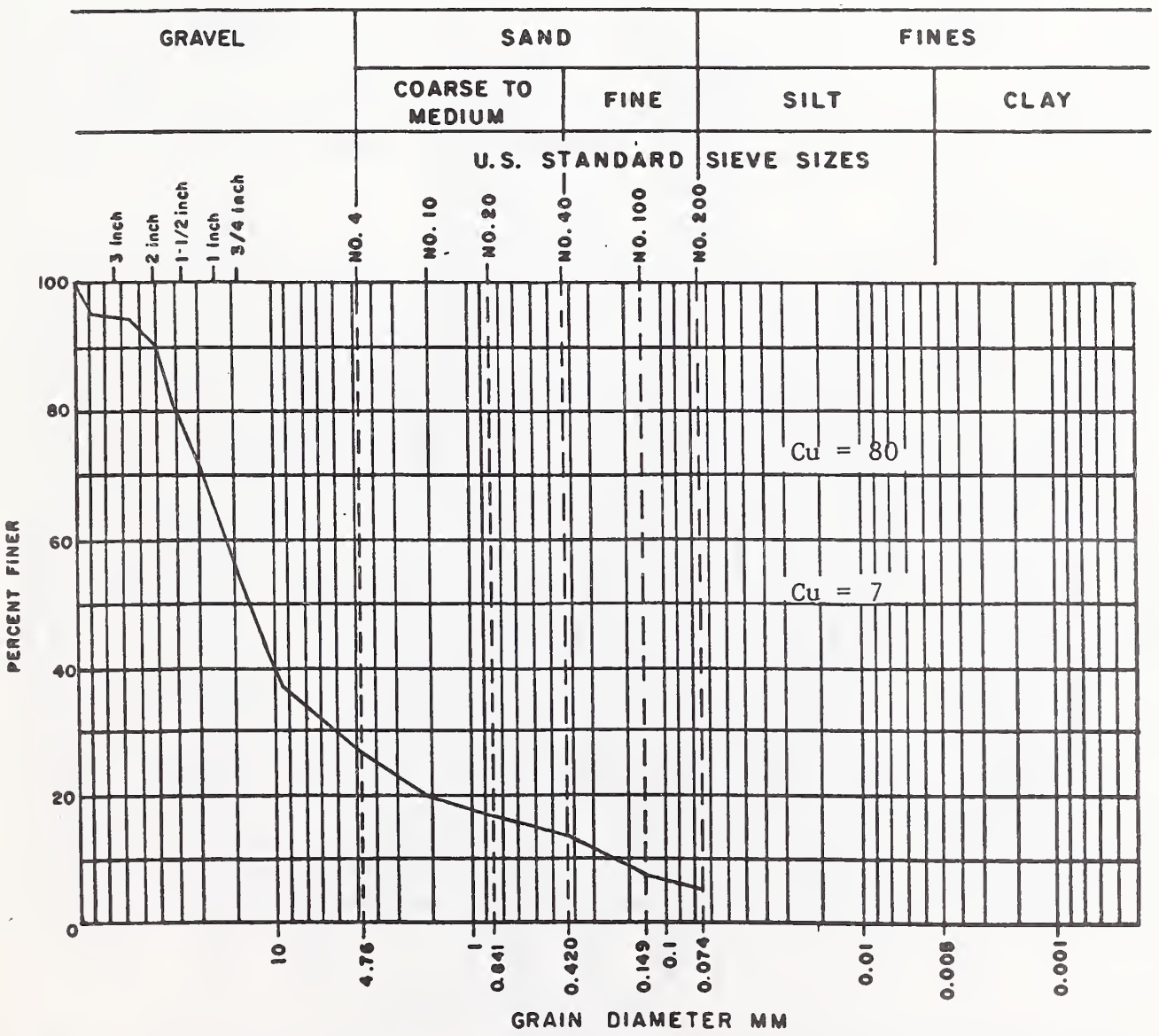
DEPTH FEET	LEGEND	DESCRIPTION OF MATERIAL	SAMPLE TYPE	SAMPLE FROM	SAMPLE TO	BLOWS N	M.C. %	γd pcf	L.L. %	P.I. %	NOTES
		TOPSOIL; with organics									
1.0		CLAYEY SAND with GRAVEL (SC): moist, very stiff, brown with gravel pockets	Sack	1	6				27	11	See Plate No. 3 for additional information
6.8											
7.6		SANDY SHALE; hard, grey									

FORM ST-5-80

HKM ASSOCIATES
ENGINEERS ——— PLANNERS

GRAIN SIZE DISTRIBUTION

PROJECT NO. 3M087.118 LAB NO. 4575
PROJECT NAME Petrolia Dam FIELD NO. TP302 (2.0-7.0')
DATE SAMPLED Jan, 1986 DATE TESTED Jan, 1986
SAMPLED BY DLD TESTED BY RF
TYPE SAMPLE Sack SAMPLE LOCATION Downstream of dike
SOIL DESCRIPTION POORLY GRADED GRAVEL with SAND (GP)



1)_ GRAVEL, Passing 3" & retained on no. 4 sieve	74 %
2)_ SAND, Passing no. 4 sieve & retained on no. 200 sieve.	21 %
3)_ SILT & CLAY, Passing no. 200 sieve	5 %

Granular Non-Plastic

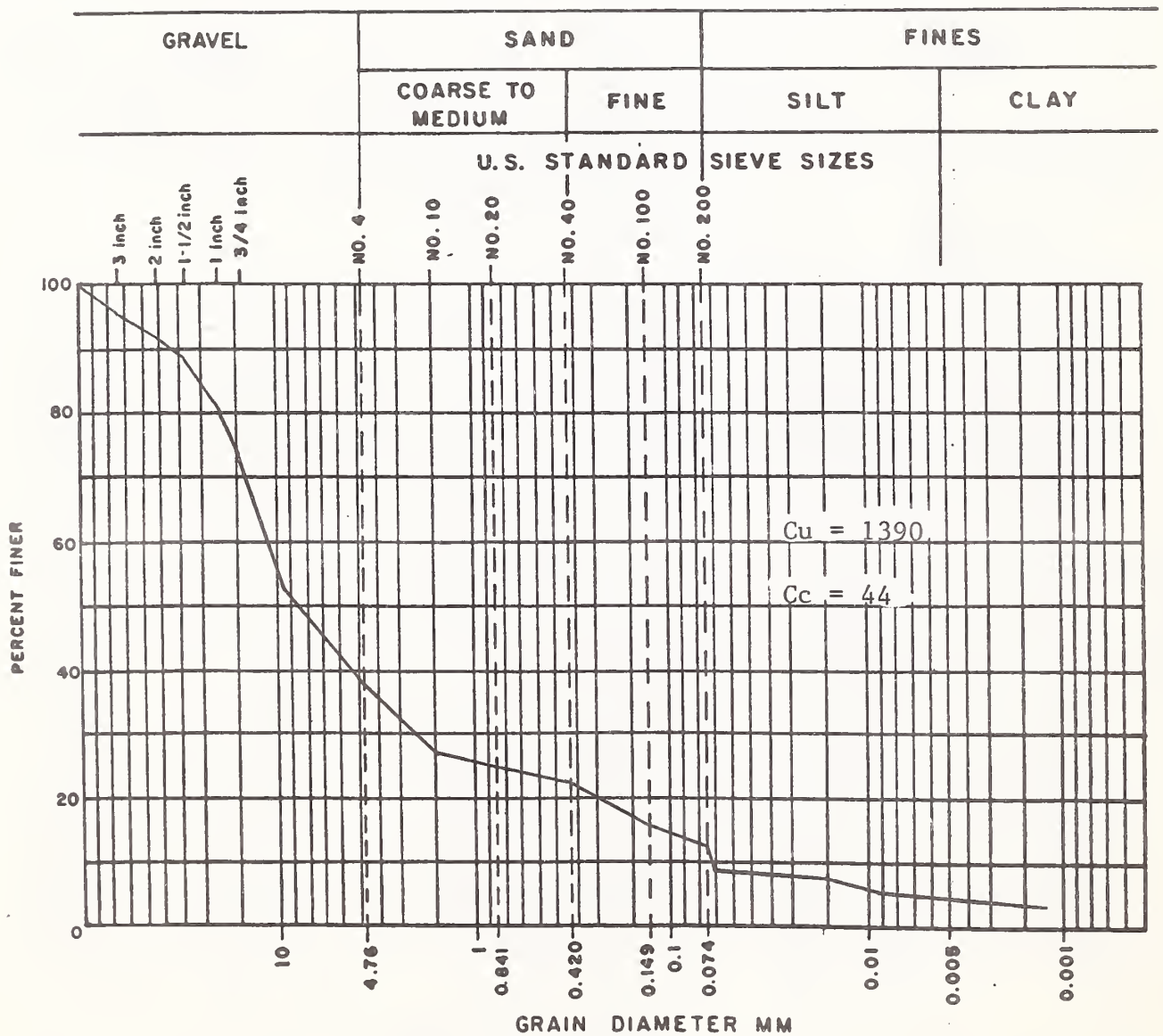
Plate No. 1

FORM ST-5-80

HKM ASSOCIATES
ENGINEERS ——— PLANNERS

GRAIN SIZE DISTRIBUTION

PROJECT NO. 3M087.118 LAB NO. 4574
PROJECT NAME Petrolia DAm FIELD NO. TP-303 (2.0-6.0')
DATE SAMPLED Jan, 1986 DATE TESTED Jan, 1986
SAMPLED BY DLD TESTED BY RF
TYPE SAMPLE Sack SAMPLE LOCATION Downstream of dike
SOIL DESCRIPTION POORLY GRADED GRAVEL with SILTY CLAY and SAND(GP-GC)



1)_ GRAVEL, Passing 3" & retained on no. 4 sieve — 63 %
2)_ SAND, Passing no. 4 sieve & retained on no. 200 sieve. — 26 %
3)_ SILT & CLAY, Passing no. 200 sieve — 7 & 4 %

Liquid Limit = 27%
Plasticity Index = 14

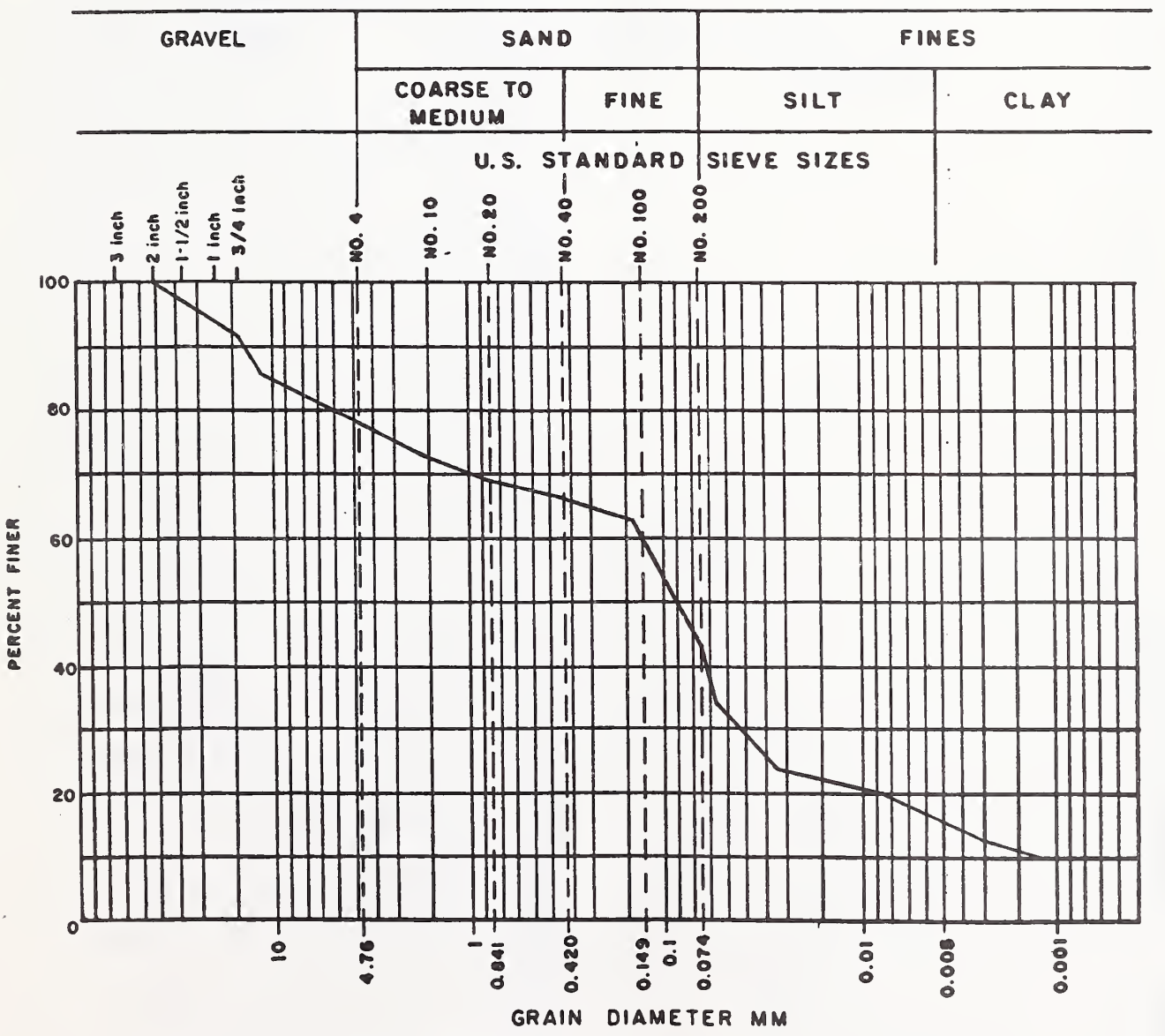
Plate No. 2

FORM ST-5-80

HKM ASSOCIATES
ENGINEERS — PLANNERS

GRAIN SIZE DISTRIBUTION

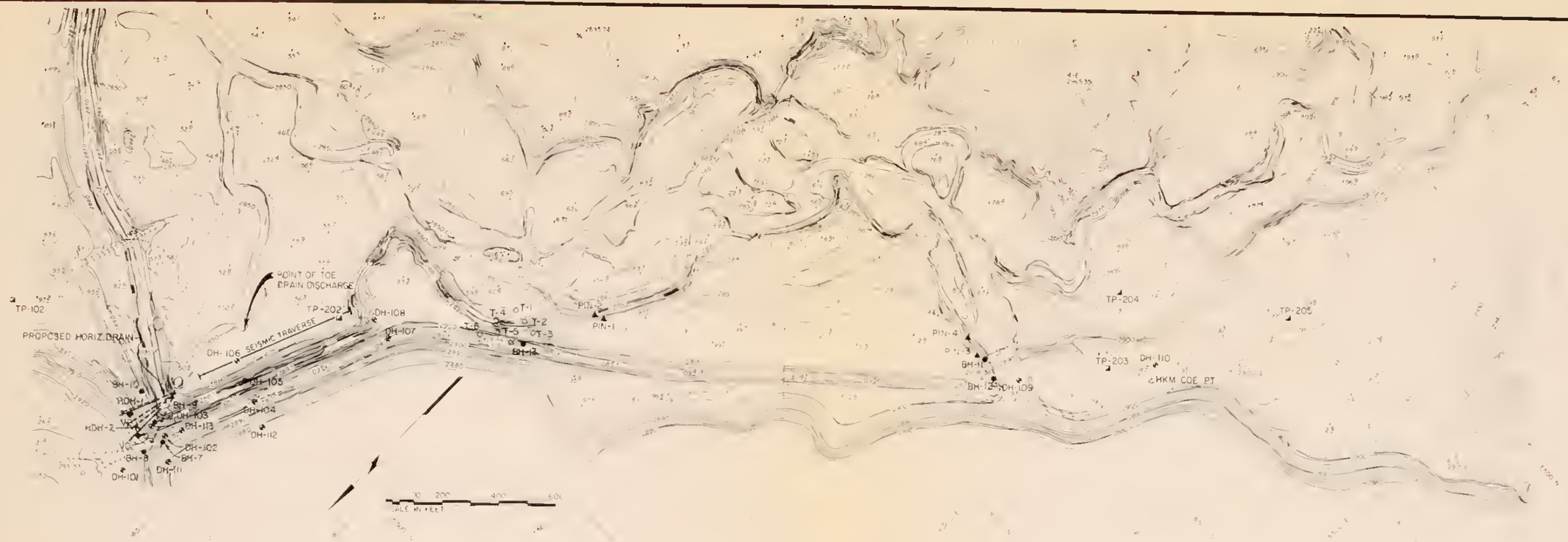
PROJECT NO. 3M087.118 LAB NO. 4574
PROJECT NAME Petrolia Dam FIELD NO. TP-306 (1.0-4.0')
DATE SAMPLED Jan, 1986 DATE TESTED Jan, 1986
SAMPLED BY DLD TESTED BY RF
TYPE SAMPLE Sack SAMPLE LOCATION Johnson Coulee
SOIL DESCRIPTION CLAYEY SAND with GRAVEL (SC)



1)_ GRAVEL, Passing 3" & retained on no. 4 sieve	22 %
2)_ SAND, Passing no. 4 sieve & retained on no. 200 sieve.	36 %
3)_ SILT & CLAY, Passing no. 200 sieve	26 & 16 %

Liquid Limit = 27%
Plasticity Index = 11

Plate No. 3

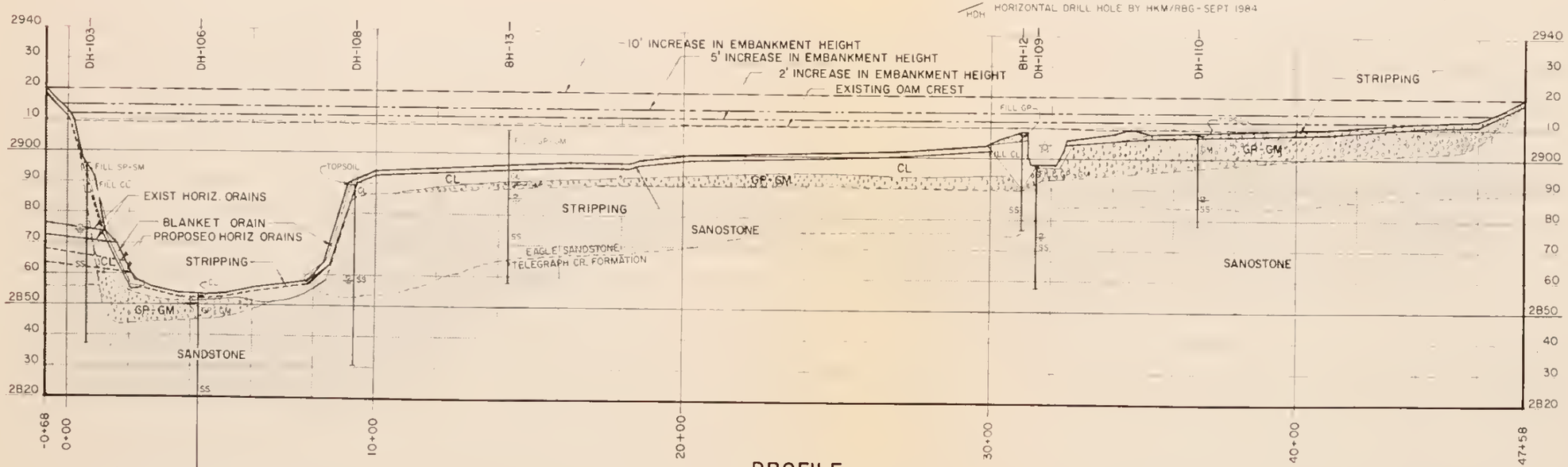


PLAN

N O T E
ALTERNATIVE INCREASES IN EMBANKMENT HEIGHT NOT SHOWN IN PLAN VIEW.

L E G E N D

- DH — DRILL HOLE BY HKM ASSOCIATES - SEPT 1984
- TP — TEST PIT BY HKM ASSOCIATES - NOV 1984
- PIN — EROSION MONITORING PIN INSTALLED BY HKM ASSOCIATES - NOV 1984
- BH — BORE HOLE BY MORRISON-MAIERLE INC - 1982
- T — PIEZOMETER INSTALLED BY SCS - 1975
- VD — VERTICAL DRAIN INSTALLED BY HKM/ROLLINS, BROWN & GUNNELL INC (RBG) - SEPT 1984
- HDH — HORIZONTAL DRILL HOLE BY HKM/RBG - SEPT 1984



N O T E
PROFILE OF TOE OF EMBANKMENT PROJECTED PERPENDICULARLY TO CENTER LINE

PROFILE
(ALONG DOWNSTREAM TOE OF EMBANKMENT)

☆N O T E
FINAL LOCATIONS OF THE PRINCIPAL AND AUXILIARY SPILLWAYS HAD NOT BEEN DETERMINED AT THE TIME OF THIS REPORT (JULY 1985)

Project No. 3M087.118 I.D. No. Date: JULY 1985 Designed DLO Drawn KEW Checked DLO Approved REB

No	Revision	By	Date
	GENERAL REVISIONS	BDH	12-18-85

PETROLIA DAM
GEOTECHNICAL INVESTIGATION

PLAN and PROFILE

HKM ASSOCIATES
ENGINEERS-PLANNERS
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Sheet No
D.1

APPENDIX E

FARM BUDGET ANALYSIS WORKSHEETS

Prepared By:
AMEC Inc.,
Agricultural Management & Economic Consulting

NET FARM INCOME AND REPAYMENT CAPACITY FOR A 500-ACRE REPRESENTATIVE FARM-RANCH, PETROLIA DAM FEASIBILITY STUDY, 1985.

Item		Total Farm
Gross Farm Income		$207,203
Crop Income -	$99,030	
Livestock Income -	$108,173	
Less: Total Variable Costs		$101,122
Return Over Variable Costs		$106,081
Less: Total Fixed Costs		$48,371
Net Farm Income		$57,710
Less: Return to Operator Labor 1/		$14,400
Less: Return to Operator Management 2/		$5,771
Less: Return to Equity		$33,002
Buildings & Improvements:	$2,225	
Machinery & Livestock:	$12,393	
Real Estate:	$18,384	
Payment Capacity		$4,537
Payment Capacity Per Acre 3/		$9.07

1/ Personal interviews revealed that skilled farm workers received $1,200/month in this area. This procedure follows Bureau of Reclamation guidelines for computing returns to the operator's labor.
2/ 10 percent of net farm income.
3/ Payment capacity of $4,537 divided by 500 acres.

CROP PRODUCTION AND DISPOSAL FOR A REPRESENTATIVE FARM-RANCH, PETROLIA DAM FEASIBILITY STUDY, 1985.

Crop	Acres	Units	Yield Per Acre 1/	Total Product	Farm Use	Amount For Sale	Sale Price 2/	Gross Receipts
Alfalfa Hay	300	Tons	4.5	1,350	600	750	$69.41	$52,058
Alfalfa Seed	100	Lbs.	300	30,000	0	30,000	1.07	32,100
Feed Barley	80	Bu.	75	6,000	280	5,720	2.60	14,872
TOTALS								$99,030

1/ Yields were obtained via personal interviews with the farmers within the study area.

2/ Bureau of Reclamation normalized prices for fiscal year 1985.

LIVESTOCK SALES AND RECEIPTS FOR A REPRESENTATIVE FARM-RANCH, PETROLIA DAM FEASIBILITY STUDY, 1985.

Livestock	Number	Weight	$/Cwt 1/	Gross Receipts
Cows (Cull)	39	1,000	$47.87	$18,669
Repl. Heifers	5	900	72.21	3,249
Heifer Calves	84	475	74.99	29,921
Steer Calves	135	525	75.81	53,730
Bulls (Cull)	3	1,500	57.85	2,603
TOTALS	266			$108,173

1/ Prices are Bureau of Reclamation normalized prices for fiscal year 1985.

TOTAL COSTS OF PRODUCTION FOR A 500 ACRE REPRESENTATIVE FARM-RANCH, PETROLIA DAM FEASIBILITY STUDY, 1985.

ITEM	Alfalfa Hay (300 Ac)	Alfalfa Seed (100 Ac)	Feed Barley (80 Ac)	Livestock (300 Cows)	Total Farm Expenses (1985)
CASH COSTS					
Seed			$677		$677
Fertilizer	$4,380	$1,460	2,360		8,200
Herbicide		1,700	200		1,900
Insecticide	2,550	1,600			4,150
Other Materials	2,025	1,000			3,025
Bees-Pollination		8,025			8,025
Fuel	5,500	500	1,600	$950	8,550
Irrigation Water	1,800	600	480		2,880
Machinery Repairs	8,400	500	1,680		10,580
Irrigation O & M	690	50	40		780
Improvement Repair	300	110	90	600	1,100
Taxes-Equipment	3,726	1,242	994		5,962
-Livestock				1,668	1,668
Utilities	4,551	400	300	500	5,751
Hired Labor	1,875	625	500	3,000	6,000
Insurance-Equip.	2,075	675	550		3,300
-Improv.	270	90	75	300	735
Seed Cleaning		2,250			2,250
Purchased Feed				1,000	1,000
Grazing Lease				6,369	6,369
Marketing Costs		200		2,130	2,330
Vet & Medicine				1,800	1,800
Breeding Fees				3,000	3,000
Gen. Overhead	1,907	1,051	477	1,066	4,501
Interest Oper.	2,791	1,539	699	1,560	6,589
VARIABLE COSTS	$42,840	$23,617	$10,722	$23,943	$101,122
FIXED COSTS					
Stand Establish.	3,750	1,250			$5,000
Machinery Deprec.					7,162
Improv. Deprec.					513
Taxes-Land					5,028
-Improv.					1,026
Interest Improv.					1,041
Interest Land					8,602
Interest Machinery and Livestock					19,999
TOTAL FIXED COSTS					$48,371
TOTAL COSTS					$149,493

VARIABLE CASH COSTS OF PRODUCING ALFALFA HAY FOR A REPRESENTATIVE FARM-RANCH, PETROLIA DAM FEASIBILITY STUDY, 1985.

ITEM	Alfalfa Hay Costs Per Acre	Alfalfa Hay Costs (300 Ac)
CASH COSTS		
Fertilizer	$14.60	$4,380
Insecticide	8.50	2,550
Other Materials	6.75	2,025
Fuel	18.33	5,500
Irrigation Water	6.00	1,800
Machinery Repairs	28.00	8,400
Irrigation Equipment O & M	2.30	690
Improvement Repairs	1.00	300
Taxes-Equipment	12.42	3,726
Utilities 1/	15.17	4,551
Hired Labor	6.25	1,875
Insurance-Equipment	6.92	2,075
-Improv.	0.90	270
Gen. Overhead	6.36	1,907
Interest Oper.	9.30	2,791
TOTAL	$142.80	$42,841

1/ 120 acres are irrigated with a side roll sprinkler, which is the reason for the relatively large utility bill for this enterprise.

VARIABLE CASH COSTS OF PRODUCING ALFALFA SEED FOR A REPRESENTATIVE FARM-RANCH, PETROLIA DAM FEASIBILITY STUDY, 1985.

ITEM	Alfalfa Seed Costs Per Acre	Alfalfa Seed Costs (100 Ac)
CASH COSTS		
Fertilizer	$14.60	$1,460
Herbicide	17.00	1,700
Insecticide	16.00	1,600
Other Materials	10.00	1,000
Bees-Pollination	80.25	8,025
Fuel	5.00	500
Irrigation Water	6.00	600
Machinery Repairs	5.00	500
Irrigation O & M	0.50	50
Improvement Repairs	1.10	110
Taxes-Equipment	12.42	1,242
Utilities	4.00	400
Hired Labor	6.25	625
Insurance-Equipment	6.75	675
-Improv.	0.90	90
Seed Cleaning	22.50	2,250
Marketing Costs	2.00	200
Gen. Overhead	10.51	1,051
Interest Oper.	15.39	1,539
TOTAL	$236.17	$23,617

VARIABLE CASH COSTS OF PRODUCING FEED BARLEY FOR A REPRESENTATIVE FARM-RANCH, PETROLIA DAM FEASIBILITY STUDY, 1985.

ITEM	Feed Barley Costs Per Acre	Feed Barley Costs (80 Ac)
CASH COSTS		
Seed	$8.46	$677
Fertilizer	29.50	2,360
Herbicide	2.50	200
Fuel	20.00	1,600
Irrigation Water	6.00	480
Machinery Repairs	21.00	1,680
Irrigation O & M	0.50	40
Improvement Repairs	1.13	90
Taxes-Equipment	12.43	994
Utilities	3.75	300
Hired Labor	6.25	500
Insurance-Equipment	6.88	550
-Improv.	0.94	75
Gen. Overhead	5.97	477
Interest Oper.	8.73	699
TOTAL	$134.02	$10,722

VARIABLE CASH COSTS OF PRODUCING LIVESTOCK FOR A REPRESENTATIVE FARM-RANCH, PETROLIA DAM FEASIBILITY STUDY, 1985.

ITEM	Livestock Costs Per Animal Unit	Livestock Costs (305 AU)
CASH COSTS		
Fuel	$3.11	$950
Improvement Repairs	1.97	600
Taxes-Livestock	5.47	1,668
Utilities	1.64	500
Hired Labor	9.84	3,000
Insurance-Improv.	0.98	300
Purchased Feed	3.28	1,000
Grazing Lease	20.88	6,369
Marketing Costs	6.98	2,130
Vet & Medicine	5.90	1,800
Breeding Fees	9.84	3,000
Gen. Overhead	3.54	1,066
Interest Oper.	5.18	1,560
TOTAL	$78.13	$23,943

NOTE: Raised feed is not directly charged to the livestock enterprise.

LIVESTOCK INVENTORY AND PRODUCTION FOR A REPRESENTATIVE FARM-RANCH, PETROLIA DAM FEASIBILITY STUDY, 1985

Livestock	Begin. Inv. Number	Begin. Inv. Value	Purchases Number	Purchases Value	Transfer In	Number Raised	Death Loss	Trans. Out	Sales	Ending Inventory Number	Ending Inventory Value
Cows	255	$104,525			45		6	0	39	255	$104,525
Repl. Heifers	45	28,143			51		1	45	5	45	28,143
Heifer Calves	51	19,546				138	3	51	84	51	19,546
Steer Calves	0	---				138	3	0	135	0	---
Bulls	9	10,800	3	$4,500			0	0	3	9	10,800
Horses	3	1,800					0	0	0	3	1,800
TOTAL		$164,814									$164,814

Notes: 92 Percent Calf Crop
2 Percent Death Loss
15 Percent Culling Rate
90 Percent Heifers Bred
1 Bull Per 25 Cows
Heifer Calf Inventory - 51 x 525 Lbs. x .73

LIVESTOCK FEED REQUIREMENTS FOR A REPRESENTATIVE FARM-RANCH, PETROLIA DAM FEASIBILITY STUDY, 1985.

Feed or Crop	Livestock	Number Head	Days Fed	Pounds Per Day	Total Feed	Grown	Purchased
Hay	Cows	255	150	24	459 T	459 T	---
	Repl. Heifers	45	150	18	61 T	61 T	---
	Heifer Calves	51	150	12	46 T	46 T	---
	Bulls	9	150	30	20 T	20 T	---
	Horses	3	150	30	7 T	7 T	
TOTAL:						593 T	
Barley	Repl. Heifers	45	150	2	280 Bu	280 Bu	
TOTAL:						280 Bu	
Salt, Minerals	All Cattle				5 T		5 T
TOTAL:							5 T
Range	Cows	255	215	1.00 AU	1,785 AUM	1,785 AUM	
	Repl. Heifers	45	215	.75 AU	236 AUM	236 AUM	
	Bulls	9	215	1.33 AU	84 AUM	84 AUM	
	Horses	3	215	1.40 AU	30 AUM	30 AUM	
TOTAL:						2,135 AUM	

INTEREST ON BUILDING AND IMPROVEMENT DEBT AND RETURN TO EQUITY FOR A 500-ACRE REPRESENTATIVE FARM-RANCH, PETROLIA DAM FEASIBILITY STUDY, 1985.

TOTAL INVESTMENT	$73,500
REAL ESTATE DEBT-TO-ASSET RATIO 1/	15.90%
DEBT PORTION	$11,687
EFFECTIVE INTEREST RATE 2/	8.91%
Subtotal	$1,041
EQUITY PORTION	$61,814
RATE OF RETURN TO EQUITY 3/	3.60%
Subtotal	$2,225
TOTAL INTEREST AND RETURN TO EQUITY	$3,267

1/ A four year average (1982-1985) obtained from the U.S. Bureau of Reclamation, Billings, Montana.
2/ A three year average of the Twelfth Farm Credit District (1982-1984).
3/ Obtained from the U.S. Bureau of Reclamation, Billings, Montana.

BUILDING AND IMPROVEMENTS COST AND DEPRECIATION FOR A 500-ACRE REPRESENTATIVE FARM-RANCH, PETROLIA DAM FEASIBILITY STUDY, 1985.

BUILDING AND IMPROVEMENTS	1984 COST	YEARS OF USEFUL LIFE	SINKING FUND FACTOR 1/	ANNUAL DEPREC-IATION
Machine Shop	$23,000	40	0.00303	$70
Machine Shed	10,000	40	0.00303	30
Grain Bins	8,500	30	0.00746	63
Corrals	5,000	20	0.01974	99
Fences	21,000	25	0.01196	251
Dwelling (10%)	6,000	50	0.00127	8
TOTAL	$73,500			$513

1/ The sinking fund factor is calculated at an interest rate of 8.91% which is a four-year average (1982-1985) of interest rates on real estate debt, and was obtained from the U.S. Bureau of Reclamation, Billings, Montana.

LONG TERM REAL ESTATE INTEREST ON DEBT AND RETURN TO EQUITY FOR A 500-ACRE REPRESENTATIVE FARM-RANCH, PETROLIA DAM FEASIBILITY STUDY, 1985.

TOTAL INVESTMENT	$607,200
Irrigated Land - 500 acres @ $600/ac. 1/ Grazing Land - 3,840 acres @ $80/ac.	
REAL ESTATE DEBT-TO-ASSET RATIO 2/	15.90%
DEBT PORTION	$96,545
EFFECTIVE INTEREST RATE 3/	8.91%
Subtotal	$8,602
EQUITY PORTION	$510,655
RATE OF RETURN TO EQUITY 4/	3.60%
Subtotal	$18,384
TOTAL INTEREST AND RETURN TO EQUITY	$26,986

1/ $250 for land plus $350 for irrigation development.
2/ A four-year average (1982-1985) obtained from the U.S. Bureau of Reclamation, Billings, Montana.
3/ A four-year average (1982-1985) of interest rates on real estate, obtained from the U.S. Bureau of Reclamation, Billings, Montana.
4/ Obtained from the U.S. Bureau of Reclamation, Billings, Montana.

INTEREST ON MACHINERY AND LIVESTOCK DEBT AND RETURN TO EQUITY FOR A 500-ACRE REPRESENTATIVE FARM-RANCH, PETROLIA DAM FEASIBILITY STUDY, 1985.

TOTAL INVESTMENT Machinery Investment - $332,113 Livestock Investment - $164,814	$496,089
NON-REAL ESTATE DEBT-TO-ASSET RATIO 1/	30.61%
DEBT PORTION	$151,853
EFFECTIVE INTEREST RATE 2/	13.17%
Subtotal	$19,999
EQUITY PORTION	$344,236
RATE OF RETURN TO EQUITY 3/	3.60%
Subtotal	$12,393
TOTAL INTEREST AND RETURN TO EQUITY	$32,392

1/ A four-year average (1982-1985) obtained from the U.S. Bureau of Reclamation, Billings, Montana.
2/ A three-year average (1982-1984) of short term interest rates, obtained from the U.S. Bureau of Reclamation, Billings, Montana.
3/ Obtained from the U.S. Bureau of Reclamation, Billings, Montana.

MACHINERY COMPLEMENT AND DEPRECIATION FOR A 500-ACRE REPRESENTATIVE FARM-RANCH, PETROLIA DAM FEASIBILITY STUDY, 1985.

MACHINE/VEHICLE	1984 COST	YEARS OF USEFUL LIFE	SINKING FUND FACTOR 1/	ANNUAL DEPREC-IATION
Vehicles :				
Pickup - 3/4 Ton (75%)	$9,488	9	0.06440	$611
Truck - 2 Ton	30,500	25	0.00626	191
Automobile (50%)	5,000	9	0.06440	322
Tractors :				
100 Hp	38,750	25	0.00626	243
70 Hp	23,200	19	0.01387	322
Tillage :				
Plow - 3-16's	5,950	15	0.02440	145
Roller Harrow - 12'	5,000	25	0.00626	31
Leveler - 45' x 12'	8,375	25	0.00626	52
Tandem Disc - 12'	6,100	15	0.02440	149
Field Cultivator - 12'	3,250	20	0.01211	39
Spike Harrow - 24'	775	25	0.00626	5
Planting :				
Grain Drill - 12'	9,250	25	0.00626	58
Harvest :				
Swather - 14'	22,200	15	0.02440	542
Combine	59,400	25	0.00626	372
Baler	9,375	5	0.15379	1,442
Bale Wagon - Pto	18,250	10	0.05384	983
Side Delivery Rake	2,450	15	0.02440	60
Miscellaneous :				
Ditcher	1,175	25	0.00626	7
Blade	1,300	20	0.01211	16
Sprayer	2,000	20	0.01211	24
Loader - Front Mount	6,475	15	0.02440	158
Manure Spreader	3,700	15	0.02440	90
Auger - Gas 42'	2,800	15	0.02440	68
Fuel Tanks	1,600	25	0.00626	10
Shop Equipment	10,000	20	0.01211	121
Weed Burner	1,250	20	0.01211	15
Side Roll Sprinkler	42,000	15	0.02440	1,025
Livestock Equipment	2,500	15	0.02440	61
TOTAL	$332,113			$7,162

1/ The sinking fund factor is calculated at a 13.17% interest rate which is a three-year average of short term interest rates (1982-1984) and was obtained from Phil Goorian of the U.S. Bureau of Reclamation, Billings, Montana.

APPENDIX

ASSUMPTIONS USED TO CALCULATE REPAYMENT CAPACITY

1. Much of the yield information and crop production practices were obtained from direct personal interviews with the members of the Petrolia Water Users Association.

2. Ninety pounds of barley seed is used per acre and costs $4.50 per bushel.

3. The cost of 0-45-0 fertilizer is $0.28 per pound and forty-five pounds is applied per acre on alfalfa hay and alfalfa seed. In addition, application costs are estimated to be $2.00 per acre. These costs were obtained from AgriBasics, Belgrade, Montana.

4. Fifty pounds of 0-45-0 fertilizer is applied to the barley. Fifty pounds of 34-0-0 is also applied to the barley at a cost of $0.27 per pound and a $2.00 per acre application cost.

5. Interviews indicated that herbicide is applied to the alfalfa seed at a cost of $17 per acre.

6. One quart of 2,4-D (herbicide) is applied to each acre of barley and costs $10 per gallon.

7. Interviews indicated that insecticide is applied at a cost of $16 per acre of alfalfa seed and $8.50 per acre of alfalfa hay.

8. Interviews indicated that defoliant costs totaled $10 per acre on the alfalfa seed.

9. Pollination charges total 25% of the gross income from alfalfa seed production.

10. Interviews indicated that charges for cleaning alfalfa seed total $0.075 per pound.

11. Twine costs are estimated to be $1.50 per ton.

12. Current charges for irrigation water are $6 per acre ($3 per acre foot).

13. One man is hired for 6 months of the year at a cost of $1,000 per month. One-half of the time is spent caring for livestock. The remaining time is used proportionally on crop production.

14. Insurance for equipment is estimated to be 1% of the machinery value and is charged proportionally to the crop enterprises. Insurance for building and improvements is estimated to be 1% of their value and charged proportionally to the crop and livestock enterprises.

15. Information regarding property taxes was obtained from the County Assessor's Office located in Winnett, MT. Equipment taxes are calculated by multiplying their market value by 11% and by the mill levy of 163.21 (.16321) and are then divided proportionally among the crop enterprises. Livestock taxes are calculated by multiplying the market value of the livestock by 4% and by 239.21 mills. An additional tax of $0.25 per head is also levied. Land taxes are calculated by multiplying the taxable value of the land ($33.05 per acre for Class 2, Grade 4 irrigated land; and $3.72 per acre for Grade 3 grazing land) by 163.21 mills. Taxes on buildings and improvements are calculated by multiplying their market value by 8.55% and 163.21 mills.

16. Trucking costs are calculated using a truck which hauls 8 tons, with Billings as the final destination. The truck averages 5 miles per gallon and fuel is assumed to cost $1.10 per gallon.

17. The carrying capacity of the grazing land is assumed to be 25 acres per animal unit. One-half of the total grazing land required is owned (6 sections). The remaining acres are leased. It is assumed that 3 sections are leased on private contract for $10 per animal unit month (aum). Two sections are leased from the Bureau of Land Management for $1.35 per aum. One section is leased from the State of Montana for $2.84 per aum.

18. General utilities are estimated to total $2,400 per year (excluding irrigation power) and are divided proportionally to the livestock and crop enterprises. Electricity is used to power the side-roll sprinkler on some of the hay enterprise. It is estimated that this sprinkler will use 93,958 kwh of electricity at a cost of $0.028 per kwh. An additional charge of $12 per horsepower is added to the electric bill. A 60-horsepower motor is used. These rates were obtained from the Fergus Electric Cooperative. Some information was obtained from "Cost of Owning and Operating Five Different Types of Sprinkler Systems", Bulletin 1063, Revised 1983, Montana Cooperative Extension Service.

19. Fuel was assumed to cost $1.10 per gallon. Fuel and machinery variable costs were obtained from a repayment capacity study done by HKM Associates, Inc. and AMEC, Inc. for Shell Valley, Wyoming. In addition, some information was obtained from "Costs of Irrigated Crop Production for Southcentral Montana", Bulletin 1151, Revised June, 1980.

20. Improvement variable costs were calculated by using 1.4% of the value of the improvements and dividing the total costs proportionally among enterprises.

21. General overhead is calculated by multiplying all variable costs for each enterprise by 5%.

21. Interest on operating money is calculated using the average interest rate (13.94%) of the Lewistown PCA for the period 1982-1984. The average rate is multiplied by all variable costs for each enterprise and is then divided by 2 to reflect an average length of time that operating funds would be borrowed (one-half year).

APPENDIX F

PRINCIPLES AND GUIDELINES TABLES

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Table VIII-3-1—Conversion of Points to Dollar Values

Activity categories	Point values											Weighted & Indexed Value
	0	10	20	30	40	50	60	70	80	90	100	
General recreation (Points from Table VIII-3-2)	1.60	1.90	2.10	2.40	3.00	3.40	3.70	3.90	4.30	4.60	4.80	4.28
General fishing and hunting (Points from Table VIII-3-2)	2.30	2.60	2.80	3.10	3.40	3.70	4.10	4.30	4.60	4.70	4.80	4.73
Specialized fishing and hunting (Points from Table VIII-3-3)	11.20	11.50	11.70	12.00	12.30	13.50	14.70	15.60	16.80	18.00	19.00	17.72
Specialized recreation other than fishing and hunting (Points from Table VIII-3-3)	6.50	6.90	7.40	8.00	8.50	9.60	10.60	12.80	14.90	17.00	19.00	14.91

Note.—Adjust dollar value for subsequent years to reflect changes in the Consumer Price Index after July 1, 1982.

July 1, 1982 291.8
January 1, 1986 232.2 Ratio = 1.11

◯ = Point Value Assigned

Table VIII-3-2—Guidelines for Assigning Points For General Recreation

Criteria	Judgment factors				
(a) Recreation experience [1]	Two general activities [2]	Several general activities	Several general activities; one high quality value activity [3]	Several general activities; more than one high quality high activity	Numerous high quality value activities; some general activities
Total points: 30 Point value:	0-4	5-10	11-16	17-23 (20)	24-30
(b) Availability of opportunity [4]	Several within 1 hr. travel time; a few within 30 min. travel time	Several within 1 hr. travel time; none within 30 min. travel time	One or two within 1 hr. travel time; none within 45 min. travel time	None within 1 hr. travel time	None within 2 hr. travel time
Total points: 18 Point value:	0-3	4-6	7-10	11-14	15-(18)
(c) Carrying capacity [5]	Minimum facility development for public health and safety	Basic facilities to conduct activity(ies)	Adequate facilities to conduct without deterioration of the resource or activity experience	Optimum facilities to conduct activity at site potential	Ultimate facilities to achieve intent of selected alternative
Total points: 14 Point value:	0-2	3-(5)	6-8	9-11	12-14
(d) Accessibility	Limited access by any means to site or within site	Fair access, poor quality roads to site; limited access within site	Fair access, fair road to site; fair access, good roads within site	Good access, good roads to site; fair access, good roads within site	Good access, high standard road to site; good access within site
Total points: 18 Point value:	0-3	4-6	7-(10)	11-14	15-18
(e) Environmental quality	Low esthetic factors [6] exist that significantly lower quality [7]	Average esthetic quality; factors exist that lower quality to minor degree	Above average esthetic quality; any limiting factors can be reasonably rectified	High esthetic quality; no factors exist that lower quality	Outstanding esthetic quality; no factors exist that lower quality
Total points: 20 Point value:	0-2	3-6	7-10	11-(15)	16-20

TOTAL 68

[1] Value for water-oriented activities should be adjusted if significant seasonal water level changes occur.
[2] General activities include those that are common to the region and that are usually of normal quality. This includes picnicking, camping, hiking, riding, cycling, and fishing and hunting of normal quality.
[3] High quality value activities include those that are not common to the region and/or nation and that are usually of high quality.
[4] Likelihood of success at fishing and hunting.
[5] Value should be adjusted for overuse.
[6] Major esthetic qualities to be considered include geology and topography, water, and vegetation
[7] Factors to be considered as lowering quality include air and water pollution, pests, poor climate, and unsightly adjacent areas.

Table VIII-3-3—Guidelines for Assigning Points For Special Recreation

Criteria	Judgment factors				
(a) Recreation experience [1]	Heavy use or frequent crowding or other interference with use	Moderate use, other users evident and likely to interfere with use	Moderate use, some evidence of other users and occasional interference with use due to crowding	Usually little evidence of other users, rarely if ever crowded	Very low evidence of other users, never crowded
Total points: 30 Point value:	0-4	5-10	11-16	17-23	24-(30)
(b) Availability of opportunity [2]	Several within 1 hr. travel time: a few within 30 min. travel time	Several within 1 hr. travel time: none within 30 min. travel time	One or two within 1 hr. travel time; none within 45 min. travel time	None within 1 hr. travel time	None within 2 hr. travel time
Total points: 18 Point value:	0-3	4-6	7-(10)	11-14	15-18
(c) Carrying capacity [3]	Minimum facility develoomeni for public health and safety	Basic facilities to conduct activityries)	Adequate facilities to conduct without deterioration of the resource or activity experience	Optimum facilities to conduct activity at site potential	Ultimate facilities to achieve intent of selected alternative
Total points: 14 Point value:	0-2	3-5	6-(8)	9-11	12-14
(d) Accessibility	Limited access by any means to site or within site	Fair access, poor quality roads to site; limited access within site	Fair access, fair road to site; fair access, good roads within site	Good access, good roads to site; fair access, good roads within site	Good access, high standard road to site; good access within site
Total points: 18 Point value:	0-3	4-6	7-(10)	11-14	15-18
(e) Environmental quality	Low esthetic factors [4] exist that significantly lower quality [5]	Average esthetic quality; factors exist that lower quality to minor degree	Above average esthetic quality; any limiting factors can be reasonably rectified	High esthetic quality; no factors exist that lower quality	Outstanding esthetic quality; no factors exist that lower quality
Total points: 20 Point value H	0-2	3-6	7-10	11-(15)	16-20

TOTAL 73

[1] Value for water-oriented activities should be adjusted if significant seasonal water level changes occur.
[2] Likelihood of success at fishing and hunting.
[3] Value should be adjusted for overuse.
[4] Major esthetic qualities to be considered include geology and topography, water, and vegetation.
[5] Factors to be considered as lowering quality include air and water pollution, pests, poor climate, and unsightly adjacent areas.